First lifetime measurements in the ^{78}Ni region with AGATA and VAMOS at GANIL

Clément Delafosse
Institut de Physique Nucléaire d'Orsay
for the E669 collaboration

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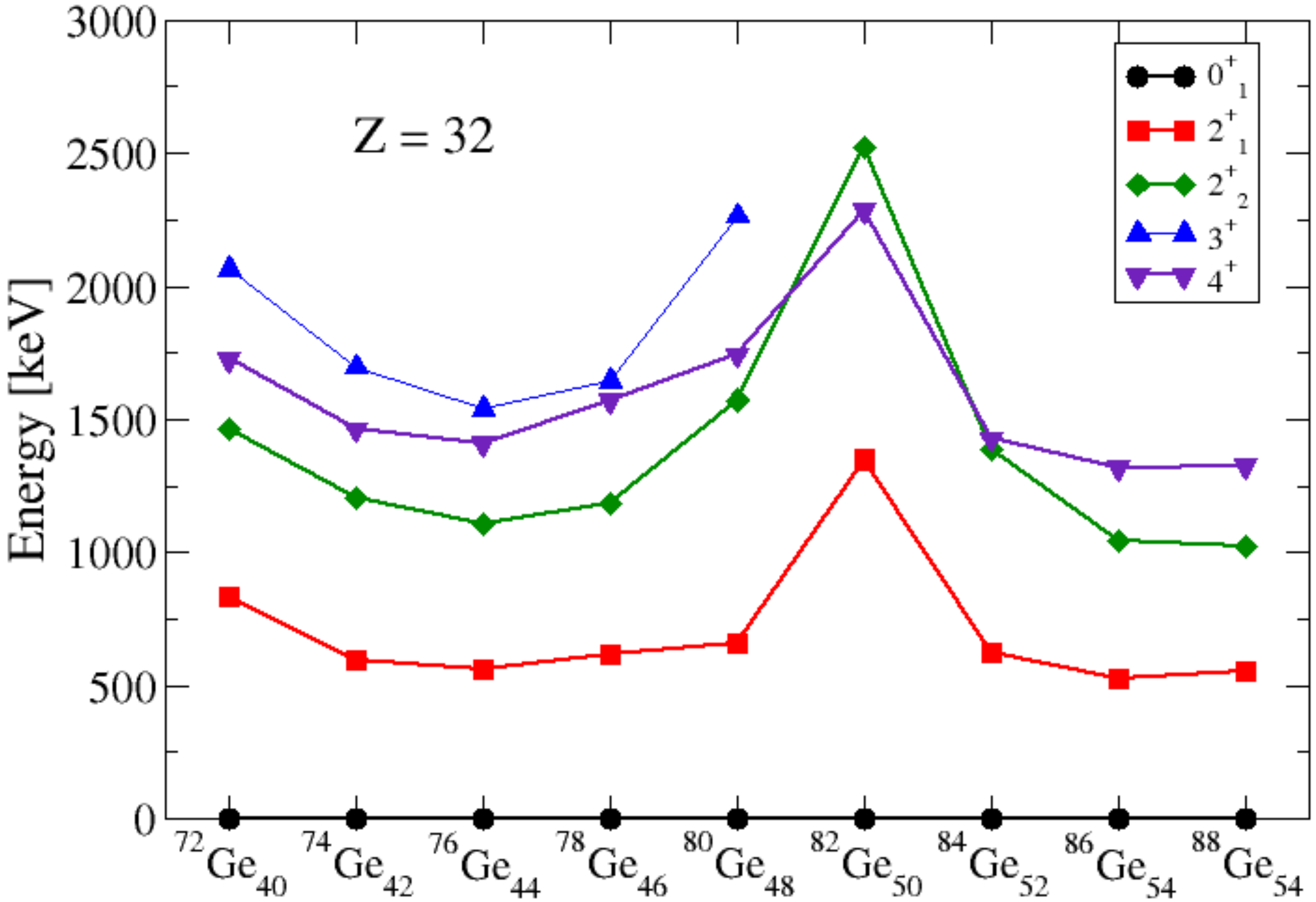
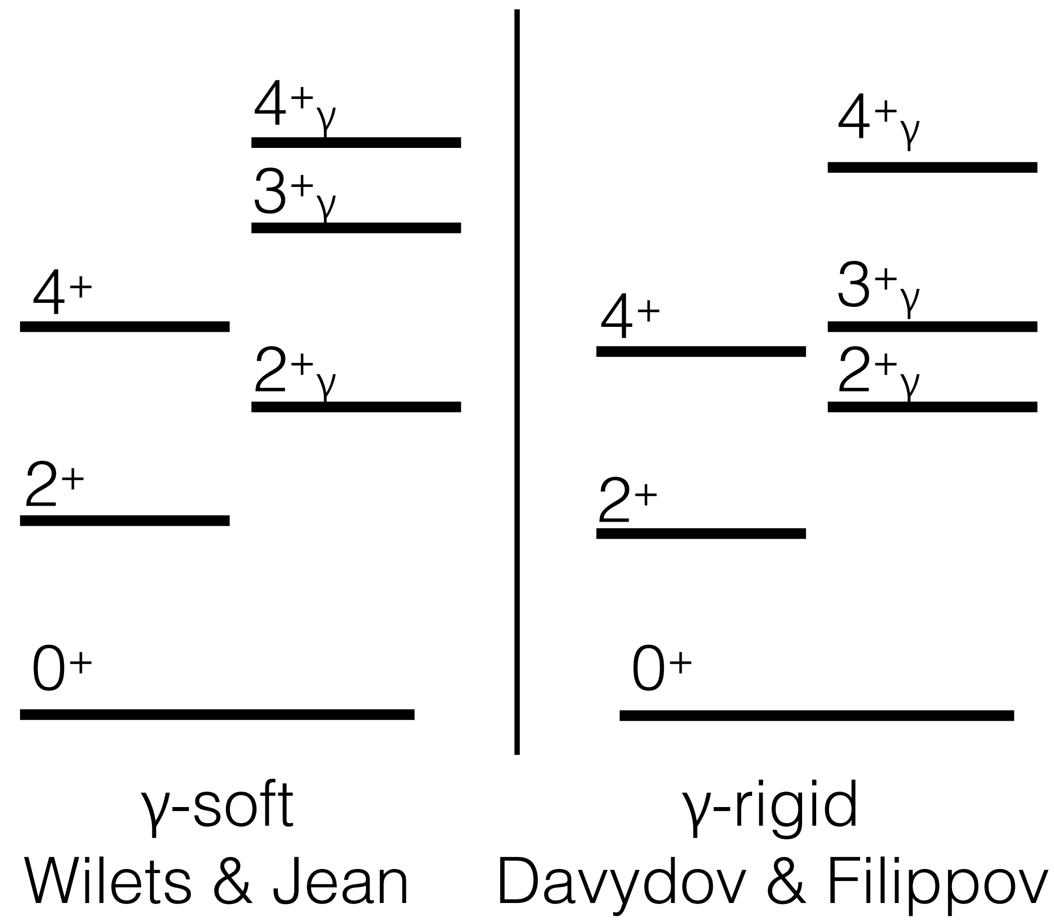
[10] *CEA de Saclay, IRFU, 91191 Gif-sur-Yvette, France*

Colloque GANIL 2017 - Amboise

Physics motivation : the Z=32 « triaxiality corridor » ?





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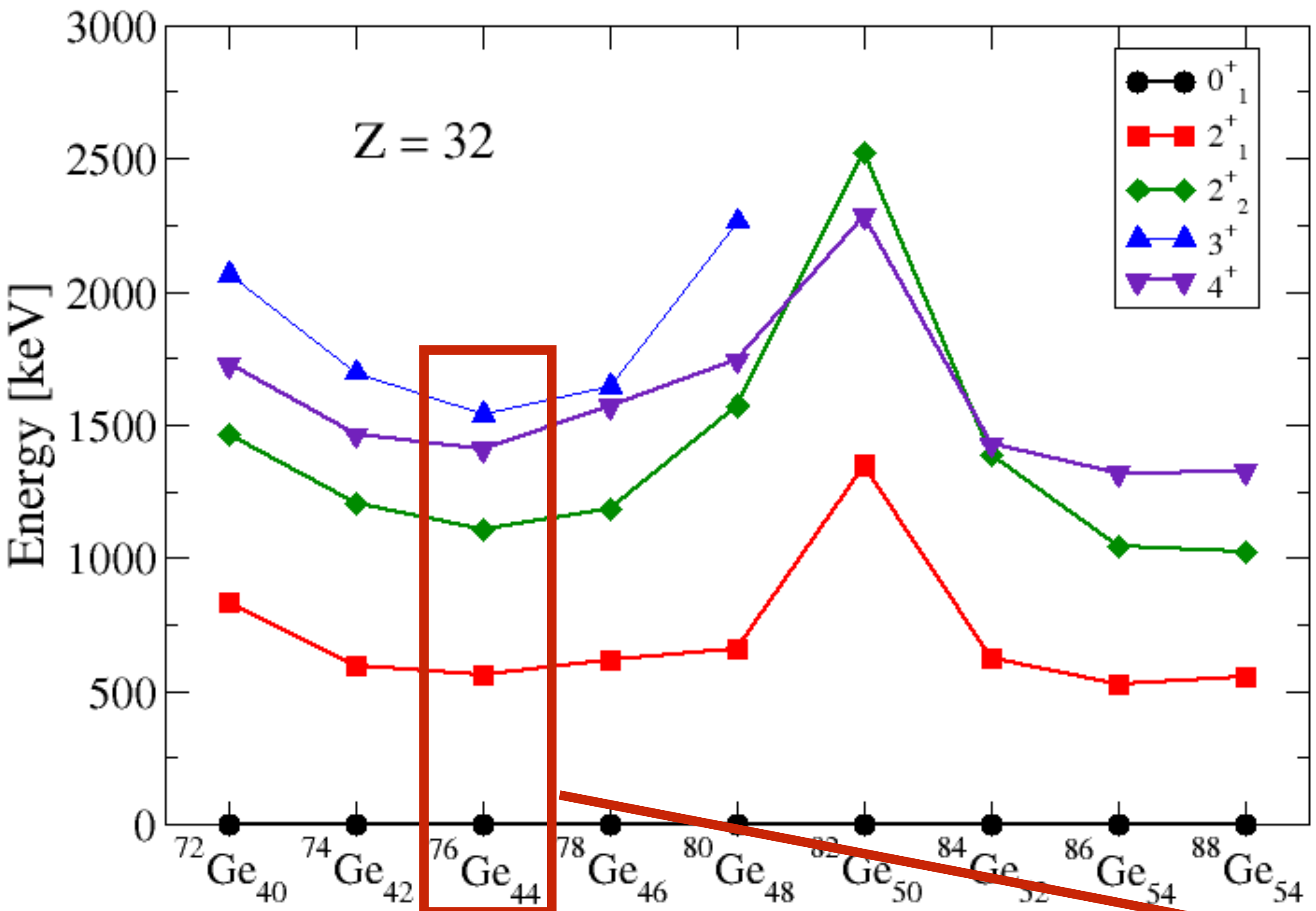
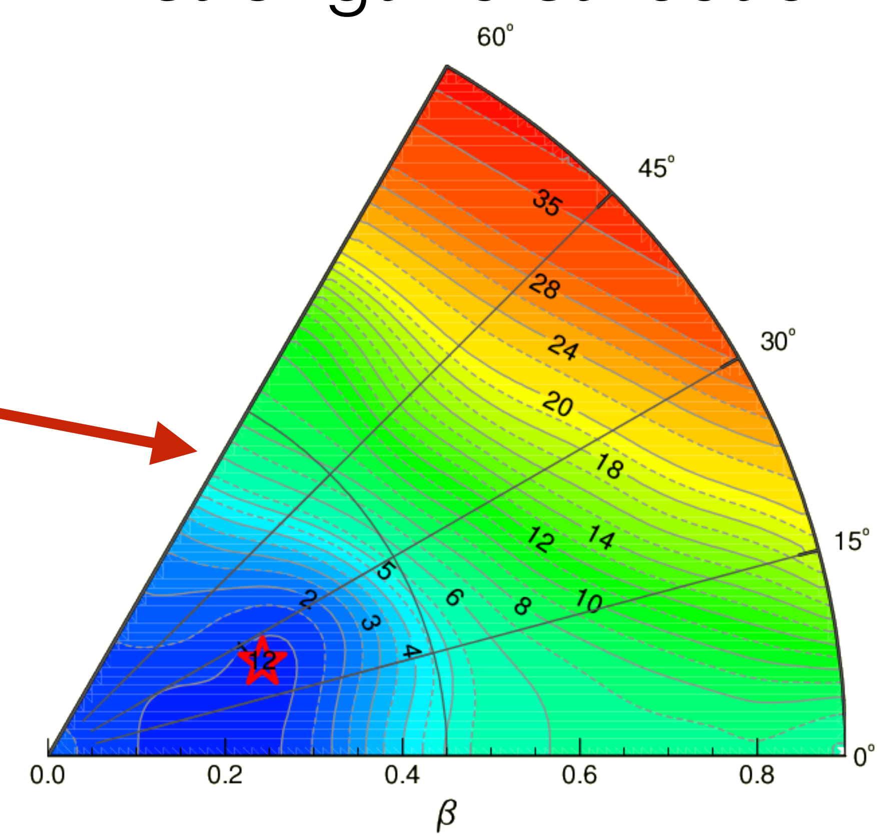


$^{76}Ge_{44}$ (stable) proven to be triaxial

S. Mukhopadhay et al. PRC 95, 014327(2017) (n,n'γ)

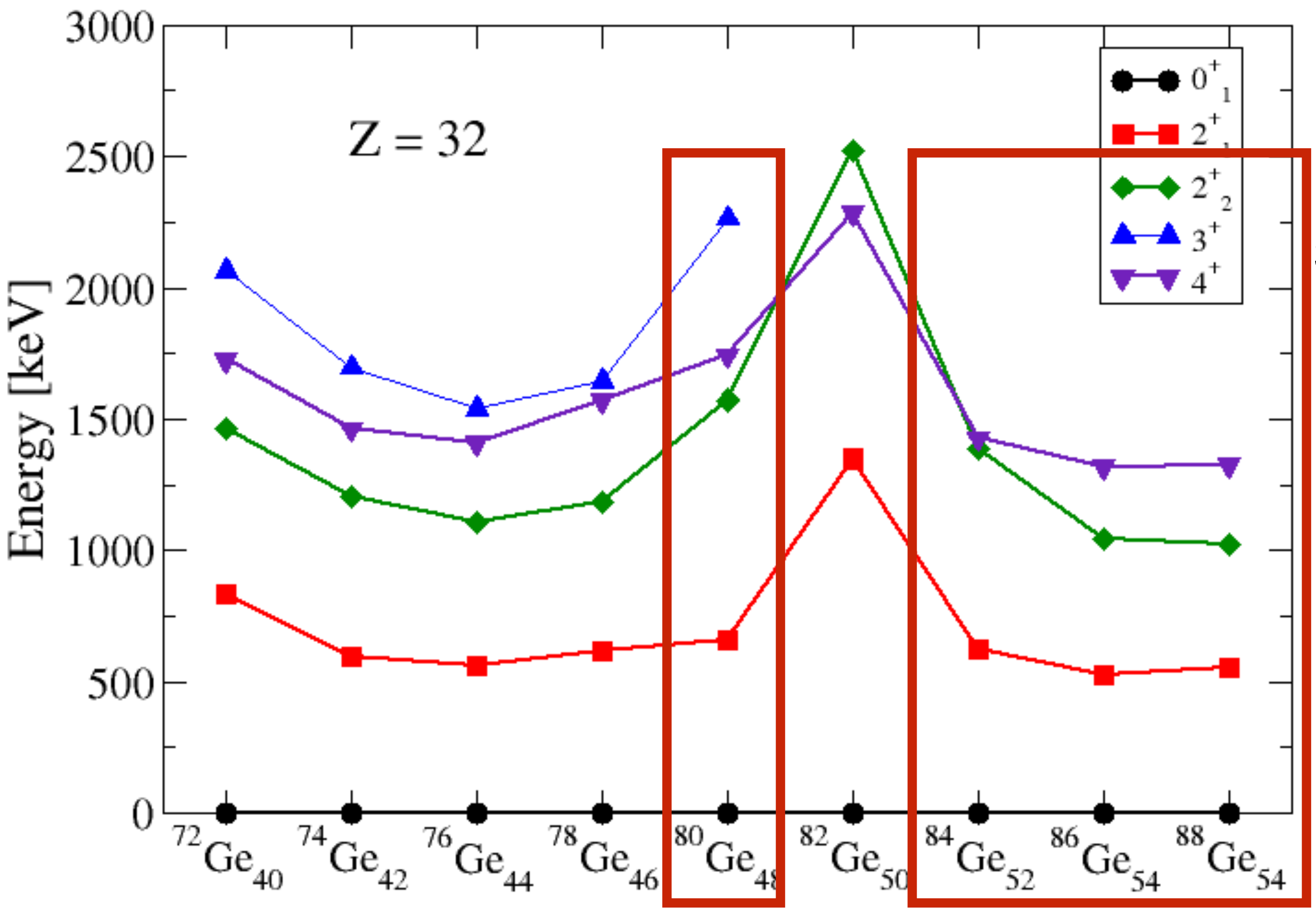
Y. Toh et al. PRC 87, 041304(R) (2013) (multistep-coulex)

Detailed knowledge of the E2 strength distribution



HFB-GCM Gogny D1S (Delaroche et al. Bruyères-le-Châtel, available online

Physics motivation : the Z=32 « triaxiality corridor » ?



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Hints of triaxiality in exotic ^{80,84,86,88}Ge

^{84}Ge (M. Lebois et al. PRC 80, 044308 (2009)) (ALTO)

E(4+)/E(2+) ratio + GCM

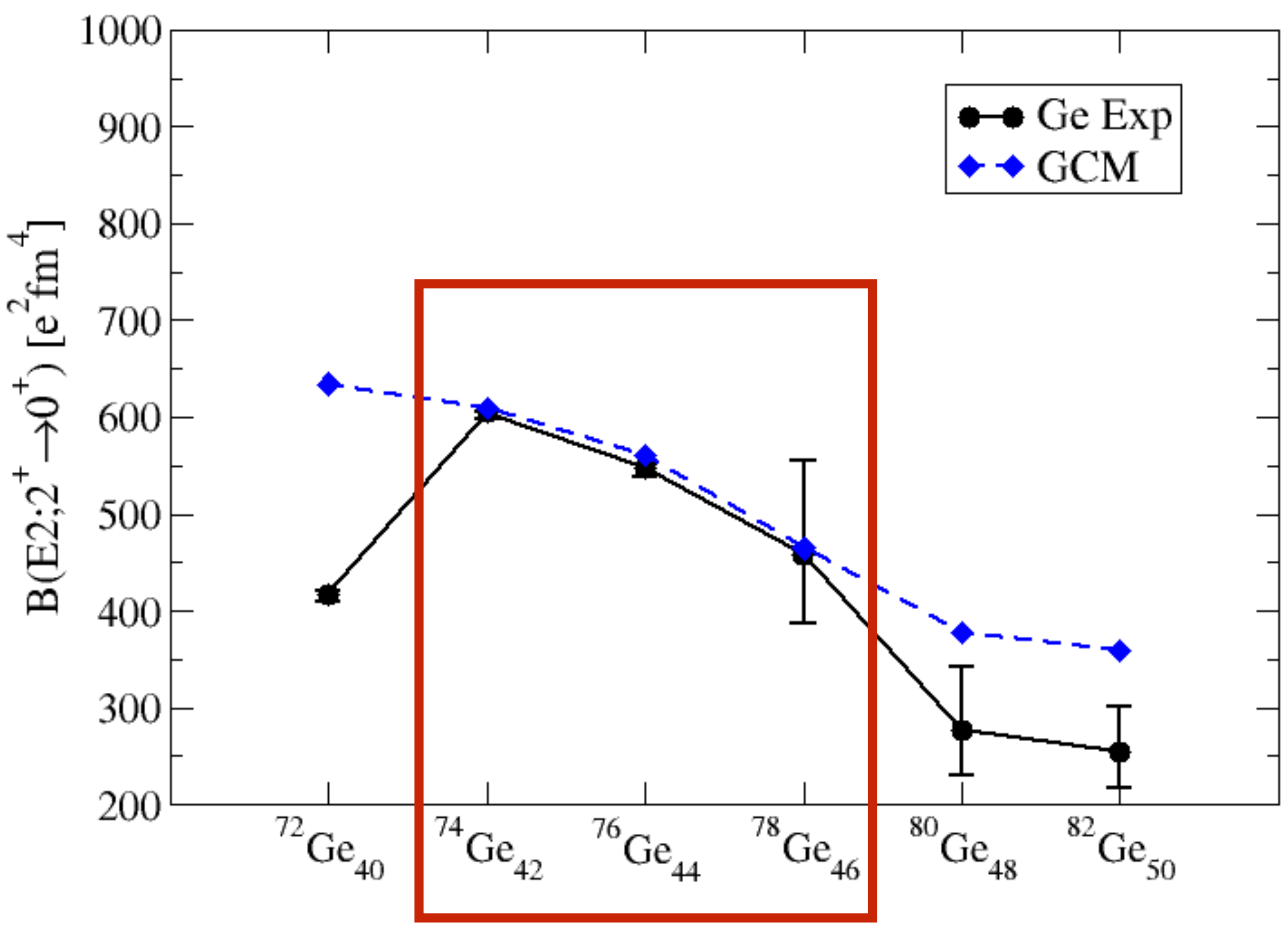
^{80}Ge (D. Verney et al. PRC 87, 054307 (2013)) (ALTO)

Level scheme and spin assignment (2^+, (3^+),4^+ states) + shell model

^{84,86,88}Ge (M. Lettman et al. PRC 96, 011301(R) (2017)) (RIKEN)

E(4+)/E(2+) ratio + shell model

Physics motivation : the Z=32 « triaxiality corridor » ?



B(E2;$2^+ \rightarrow 0^+$) values are well reproduced in $^{74,76,78}Ge_{42,44,46}$

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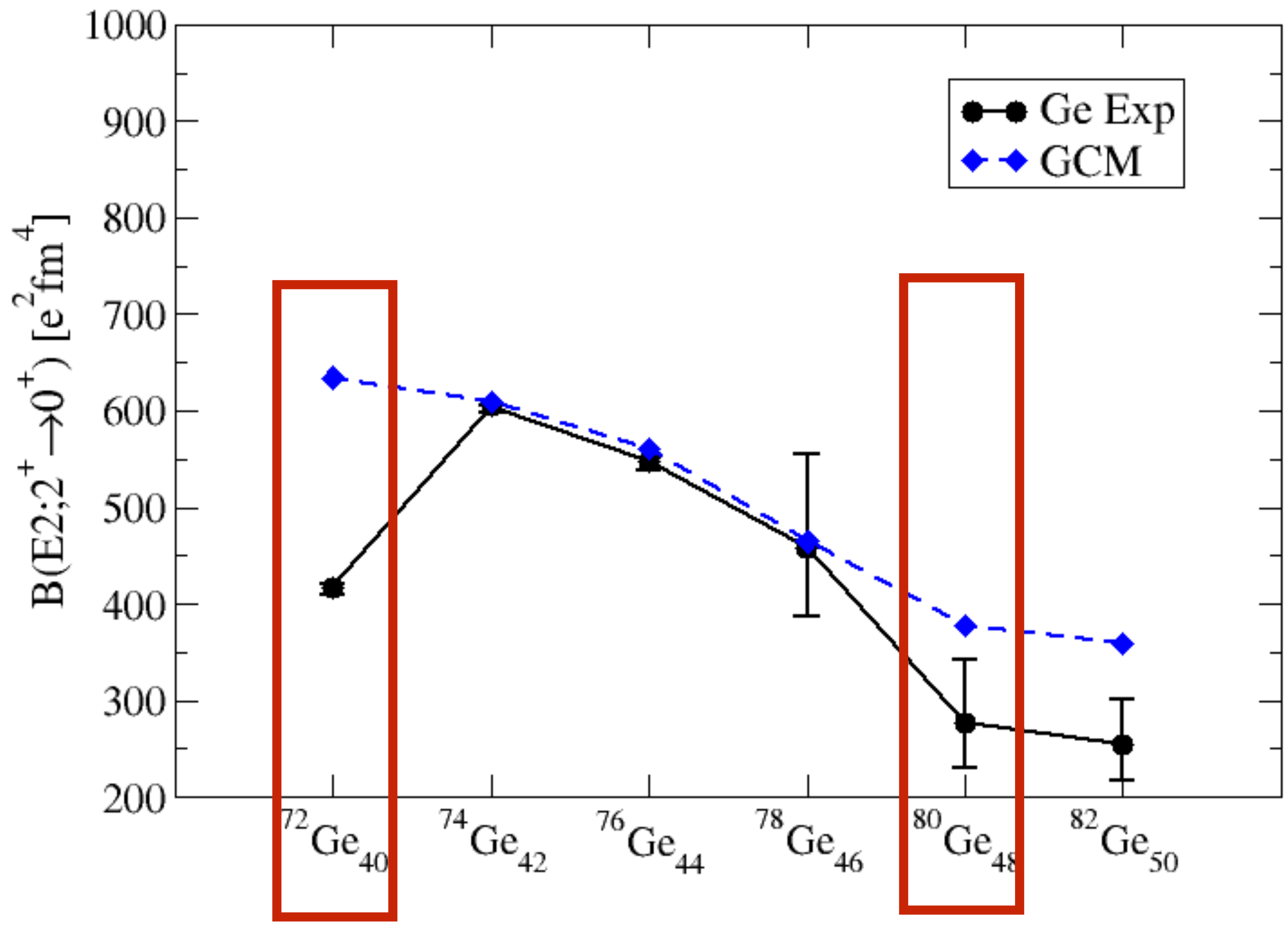

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But it not the case in $^{72,80}Ge_{40,48}$

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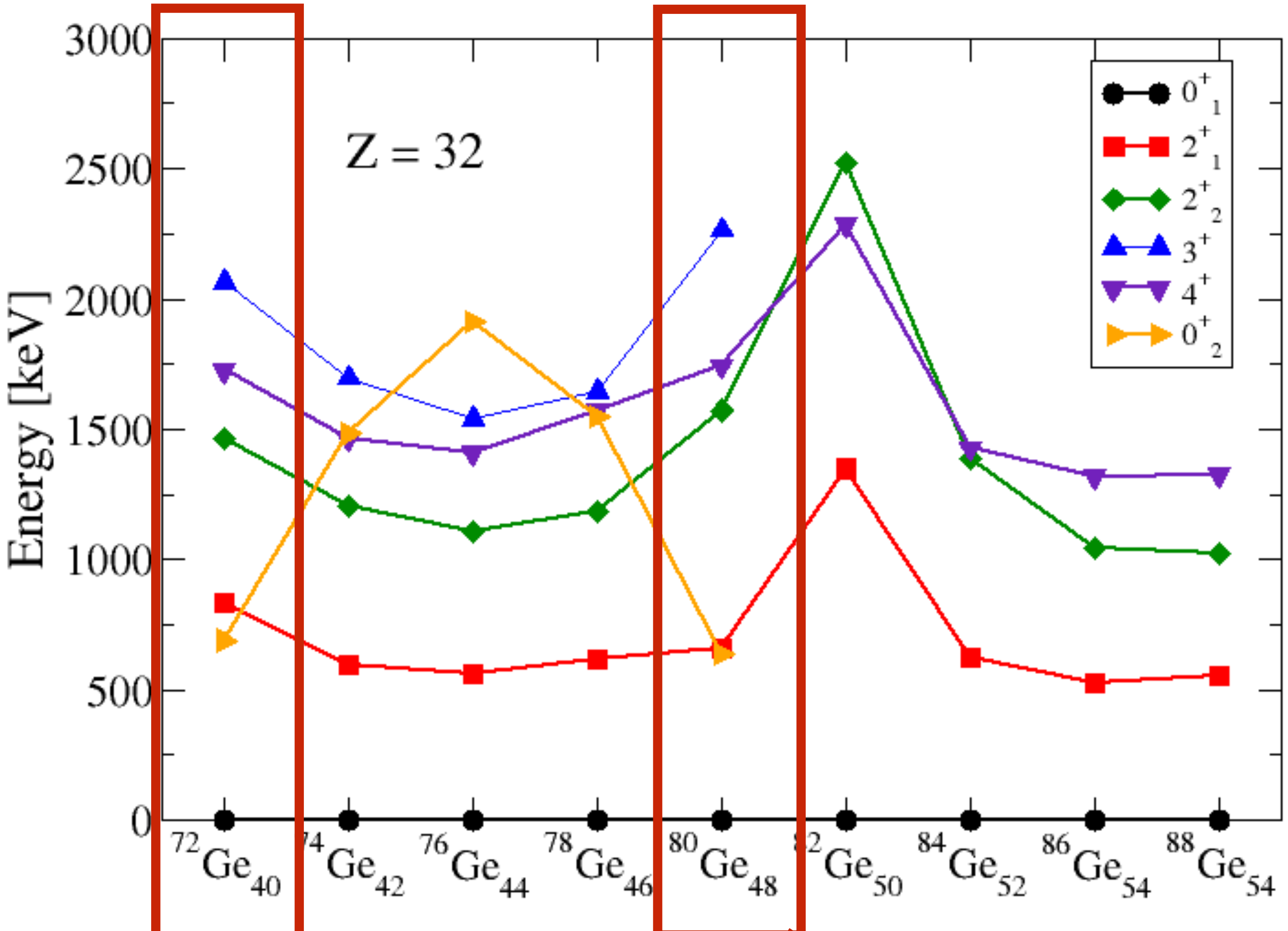

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But it not the case in $^{72,80}Ge_{40,48}$

Low lying 0^+ state in these two Ge isotopes

We may miss something in our models.

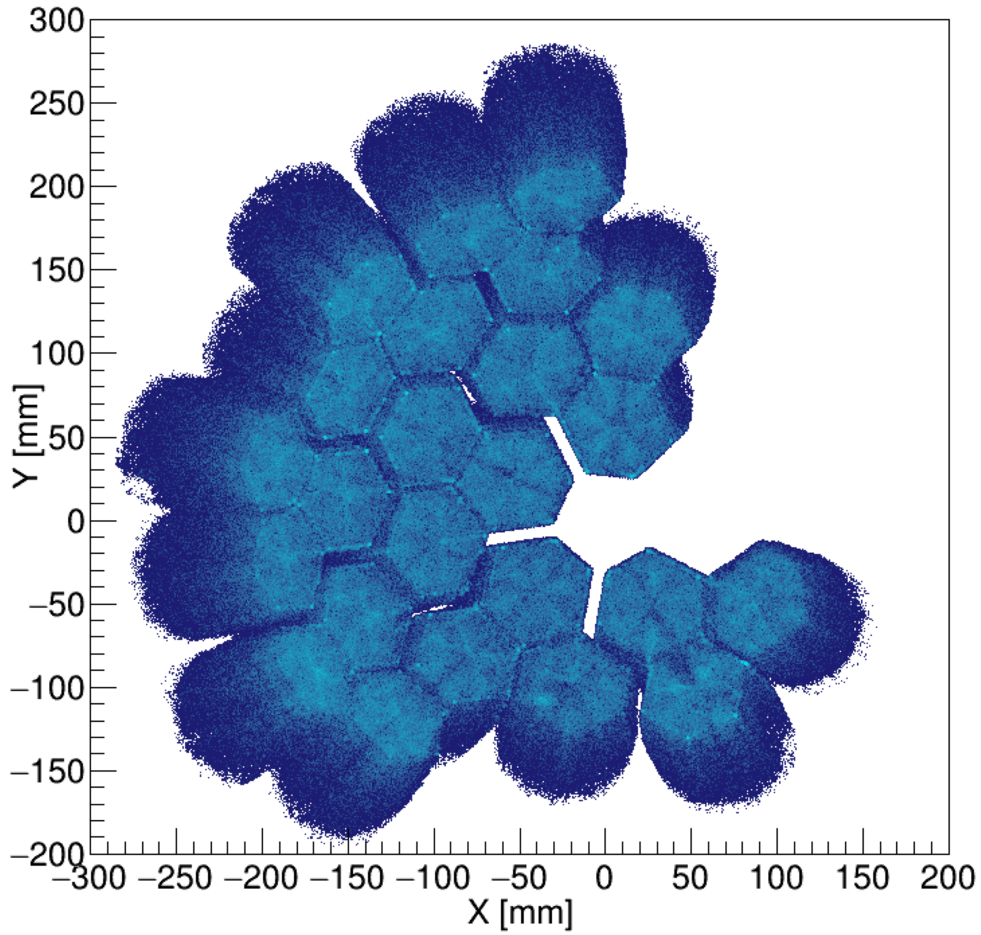
David C. Camp NPA 121, 561-591 (1968)

A. Gottardo et al. PRL 116, 182501(2016) (ALTO)
See D. Verney's presentation

Experiment E669 at GANIL

AGATA ADVANCED GAMMA TRACKING ARRAY

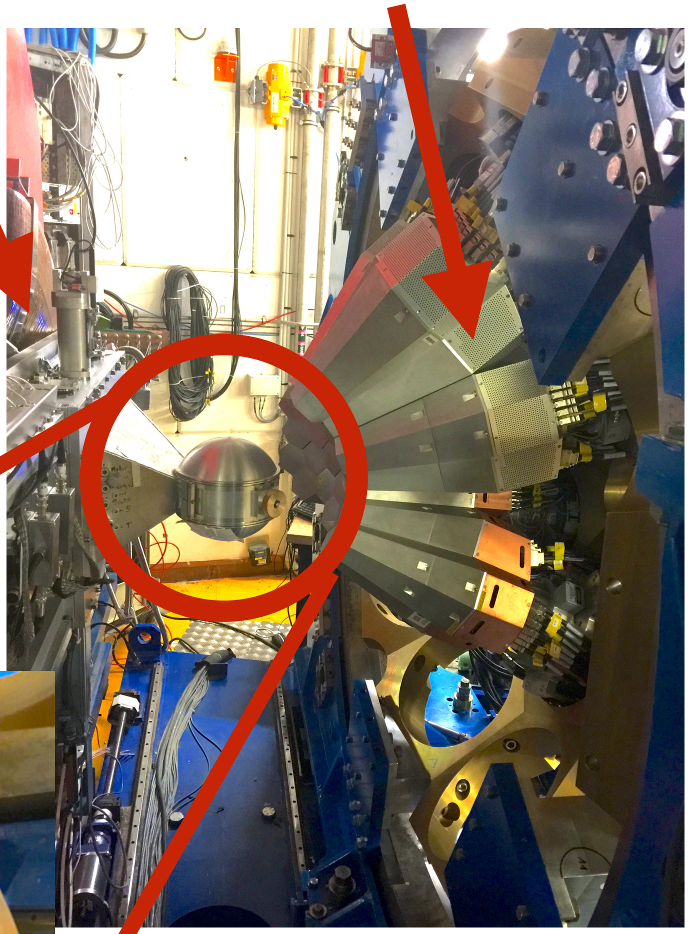
VAMOS : $B\rho_0$ = 1.1 T.m at 28°
AGATA : 8 triple clusters (24 crystals)
Beam : ^{238}U (25 nA, 6.3 AMeV)
Target : ^{9}Be (2.07 mg/cm^2)
Degrader : ^{nat}Mg (5 mg/cm^2)
Target to degrader distances : 120,270 and 520 µm

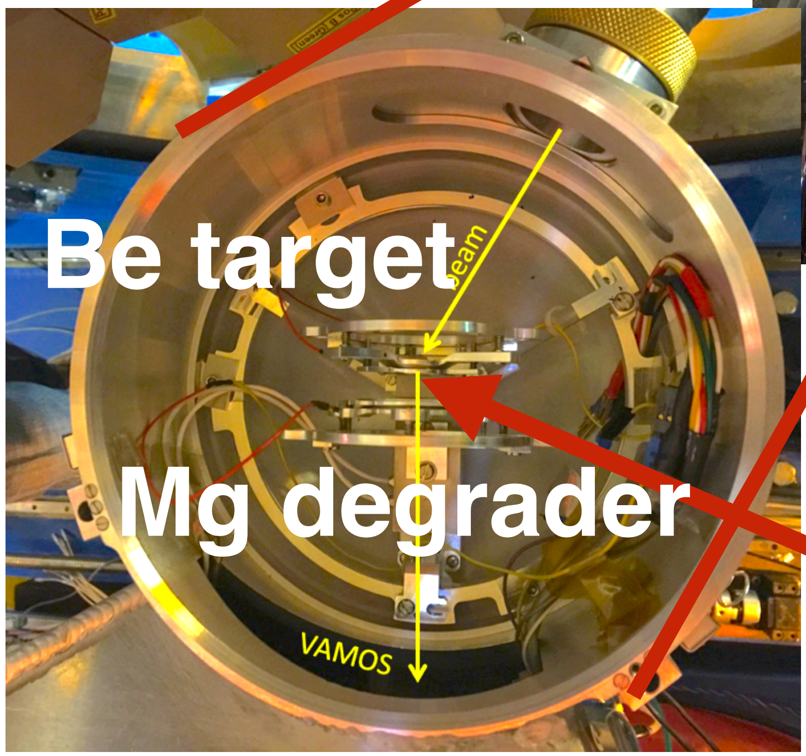


γ-hits in AGATA

VAMOS
Magnetic spectrometer

AGATA
Advanced γ-tracking array

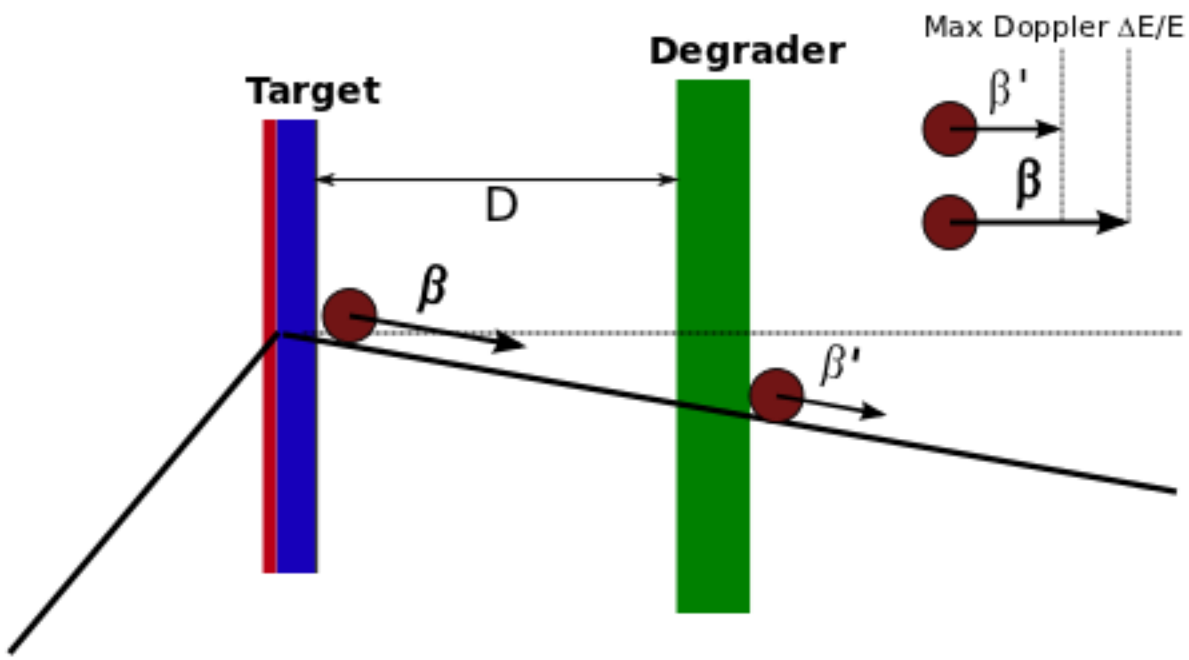




OUPS
Orsay Universal Plunger System
NIM A679 61-66 (2012)

RDDS : plunger device

RDDS : Recoil Distance Doppler Shift



If a photon is emitted before or after the degrader, the Doppler shift is different because the velocity is different

D = 120(10), 270(10), 520(10) μm

The distance D is retro-controlled by computer
The correspondance between D and ToF (Time of flight) is given by ToF = D/V (where V is the velocity of the ion before the degrader)

The velocity before the degrader is deduced from the velocity measured in VAMOS through the LISE++ software

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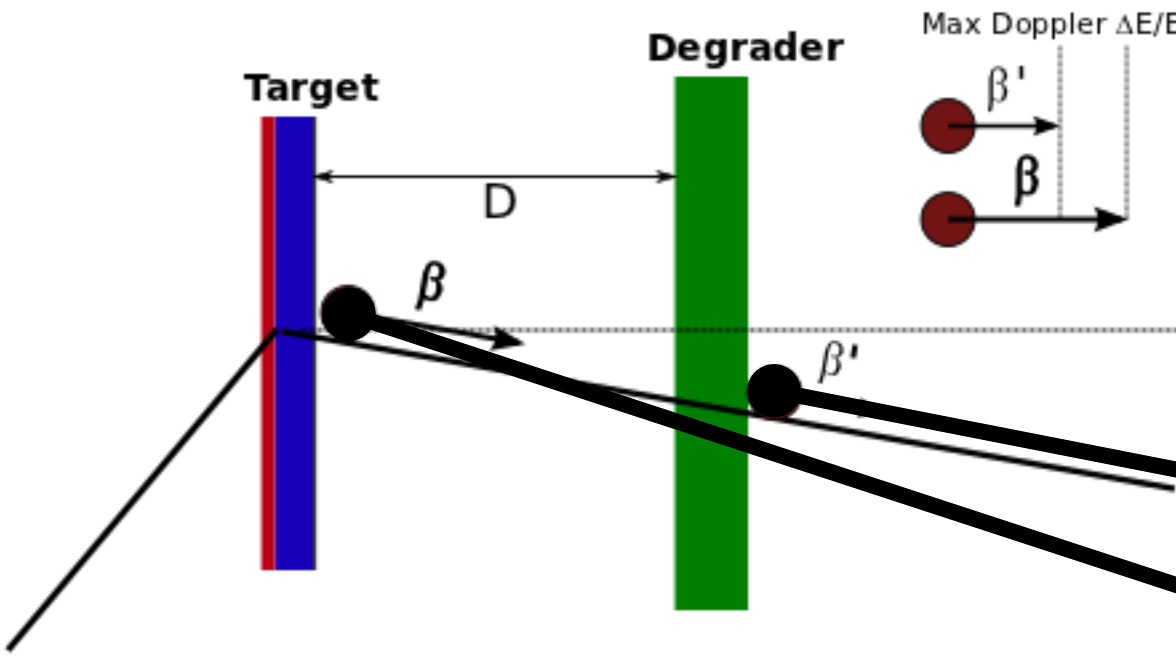

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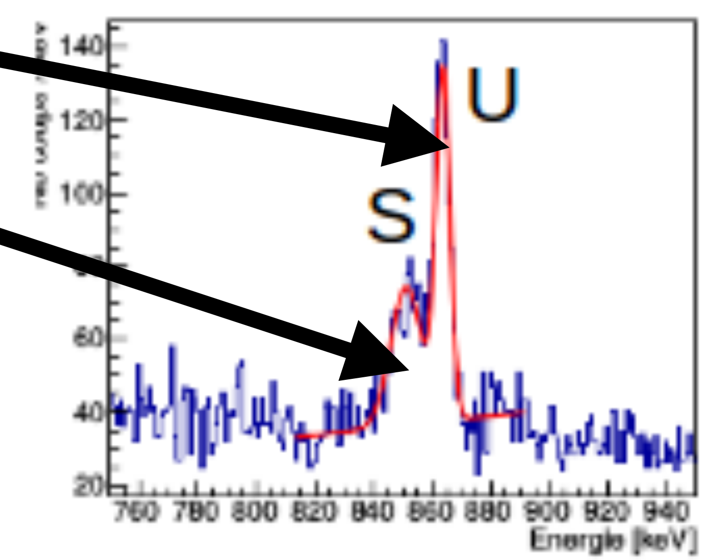

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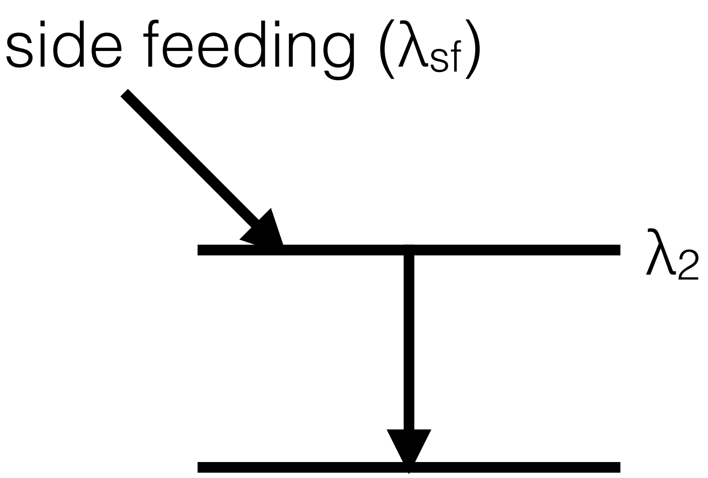
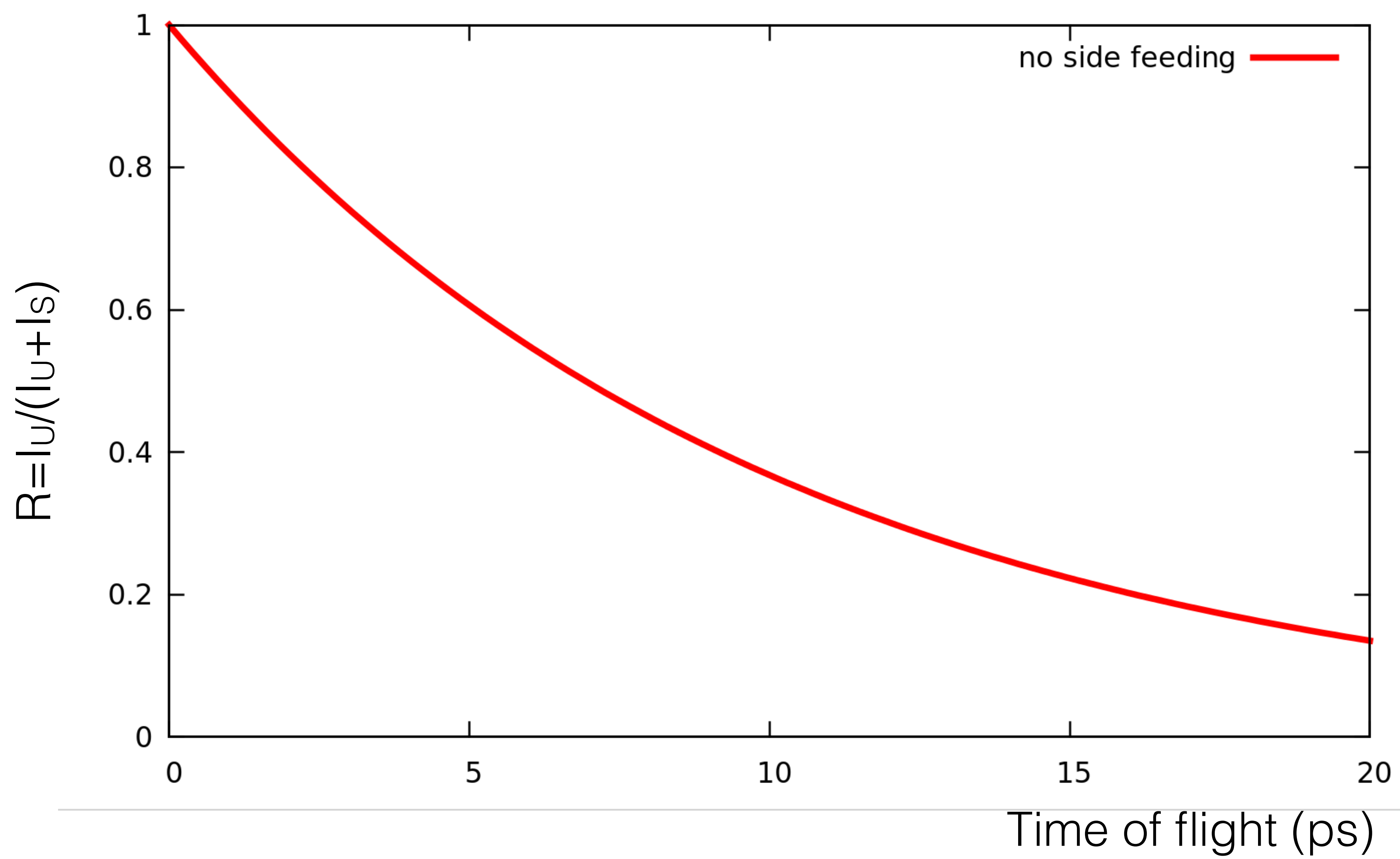
$R = I_U/(I_U+I_S)$ evolution as a function of ToF is given by Bateman equation

Side feeding

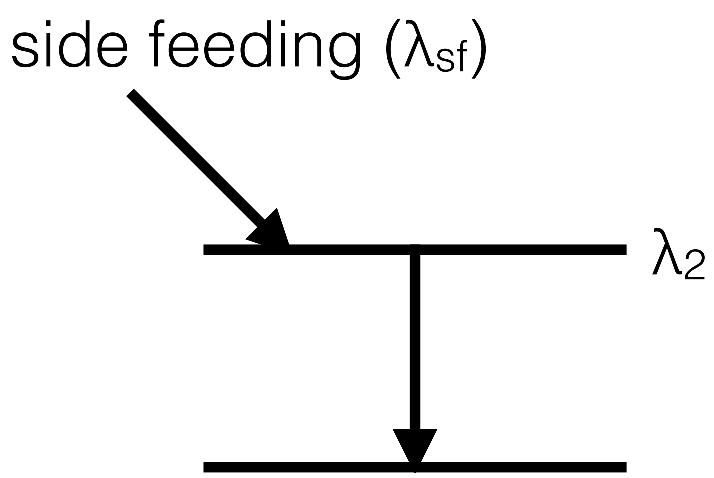


Side feeding :
Unobserved transitions modelled as a virtual state with an effective lifetime

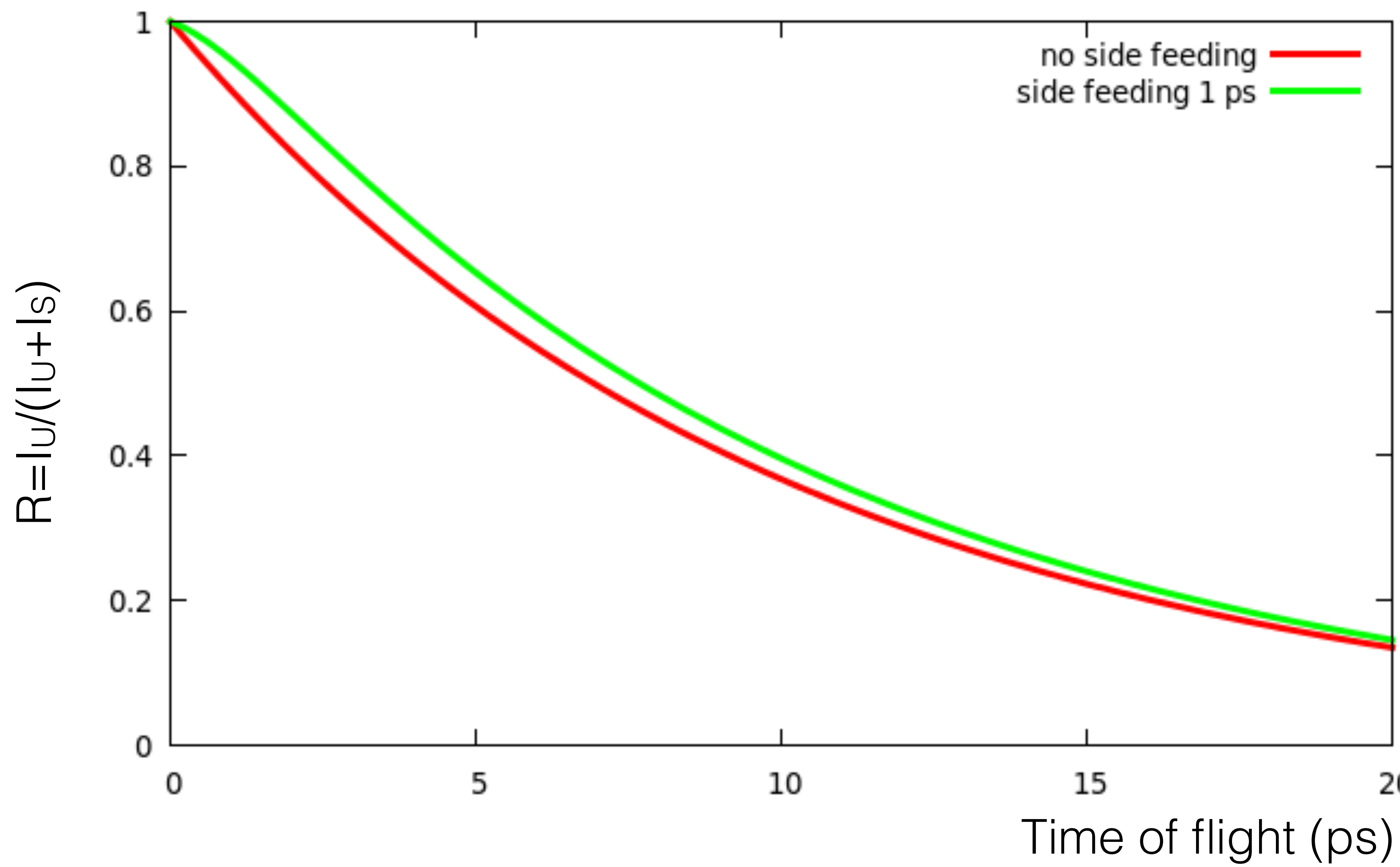


$$R(t) = 1 - \left[(1 - I_{sf})(1 - e^{-\lambda_2 t}) + \frac{\lambda_2 I_{sf}}{\lambda_2 - \lambda_{(sf)}}\left(e^{\lambda_2 t} - e^{\lambda_{sf} t}\right)\right]$$

Side feeding



Side feeding : Unobserved transitions modelled as a virtual state with an effective lifetime



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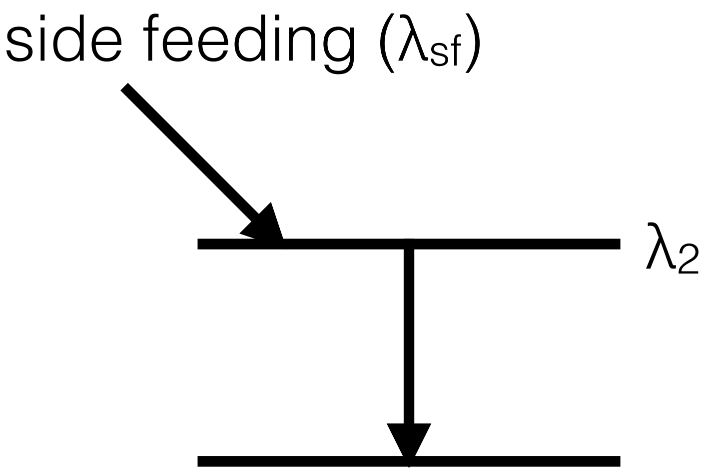

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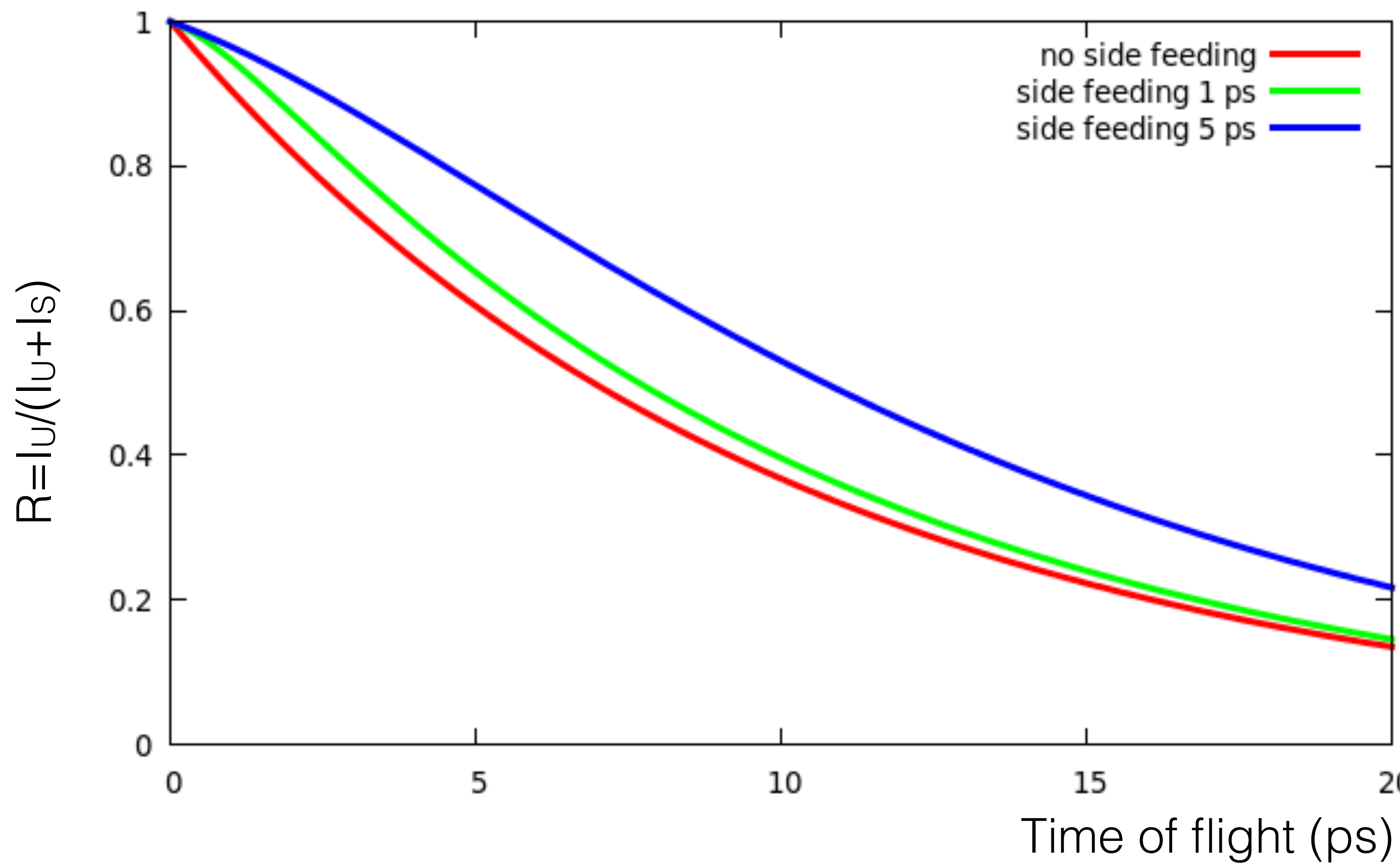

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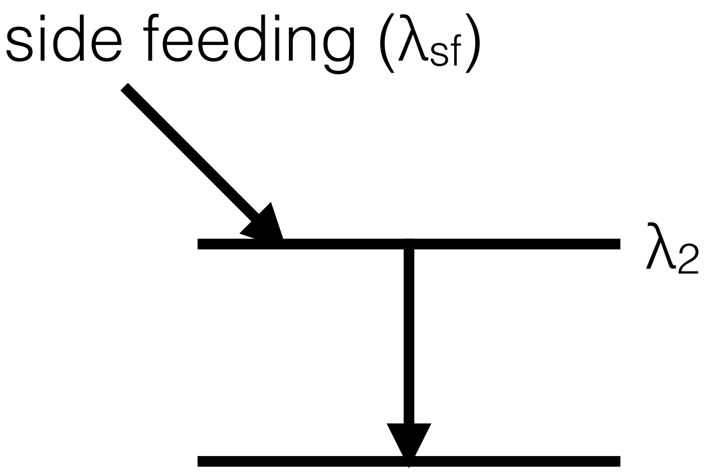

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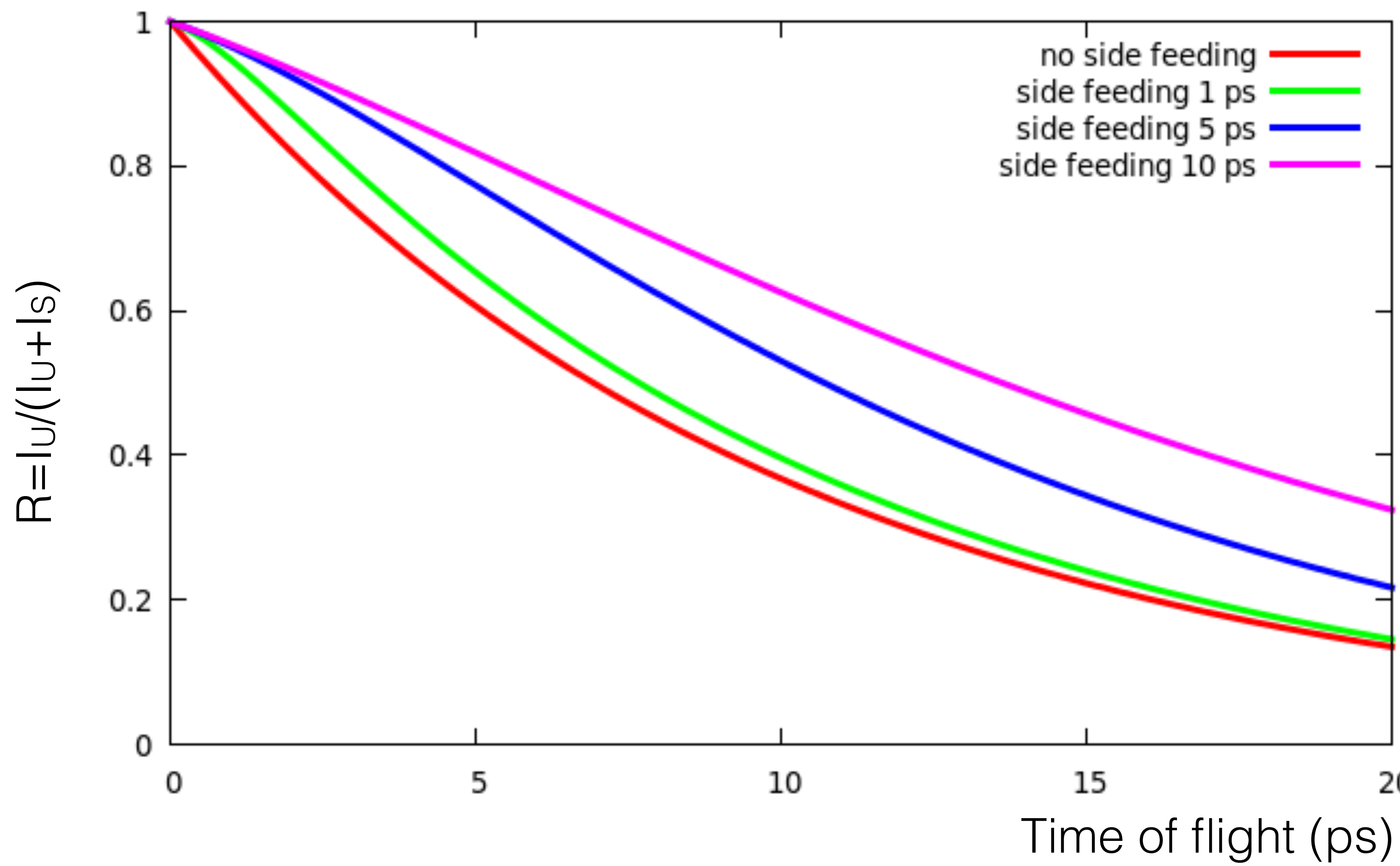

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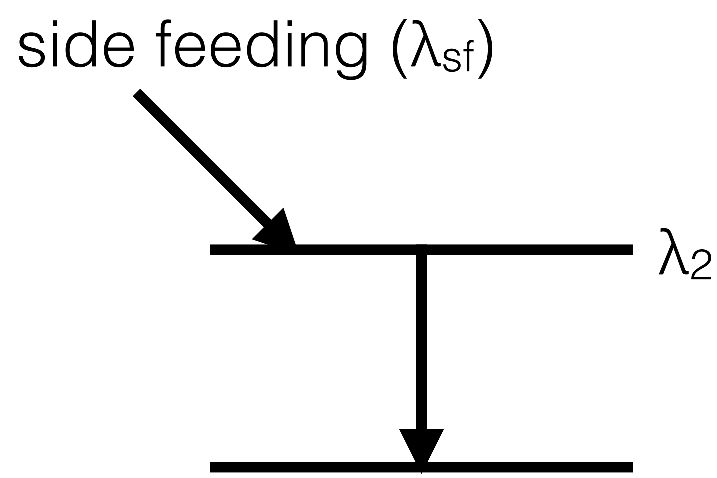

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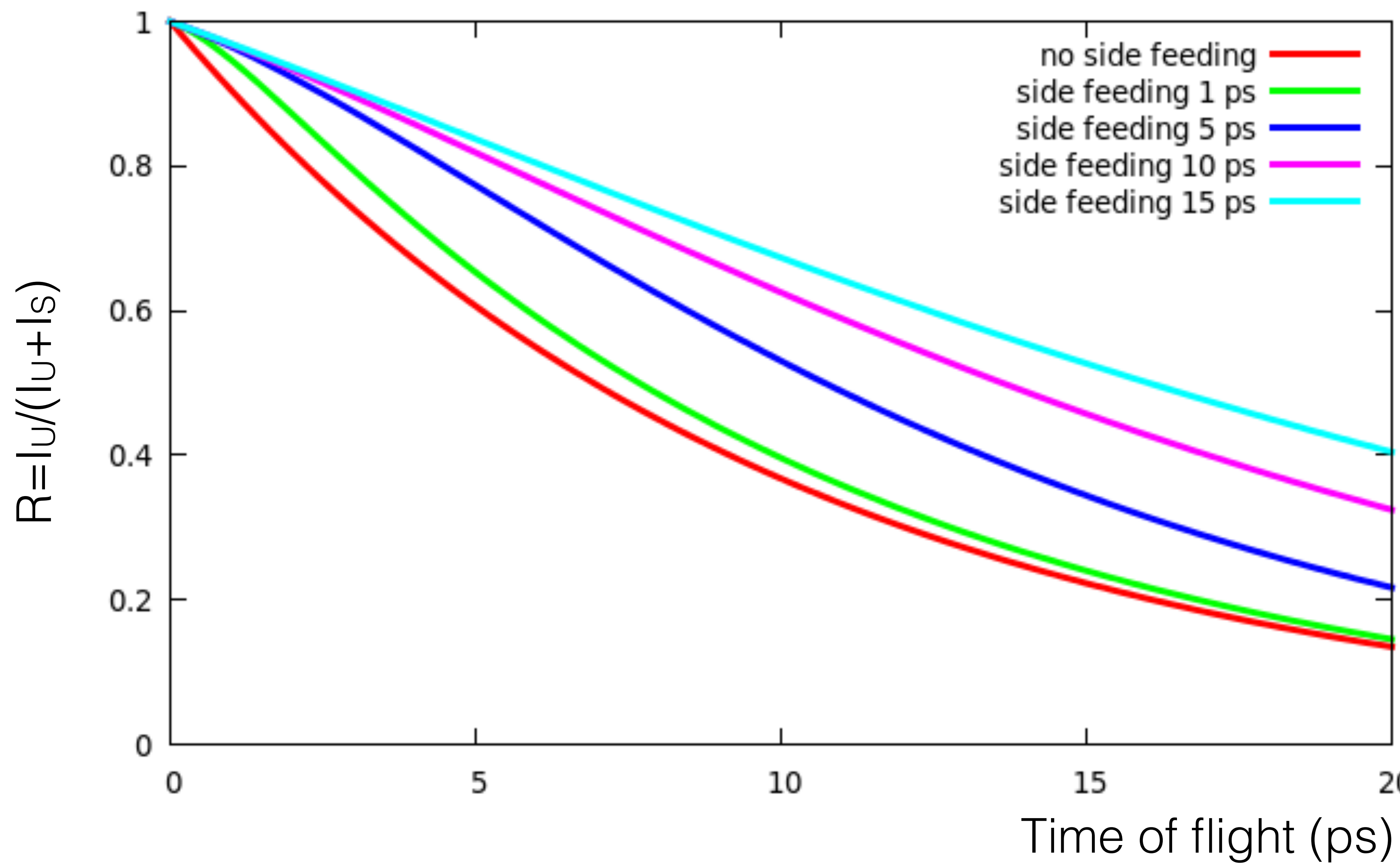

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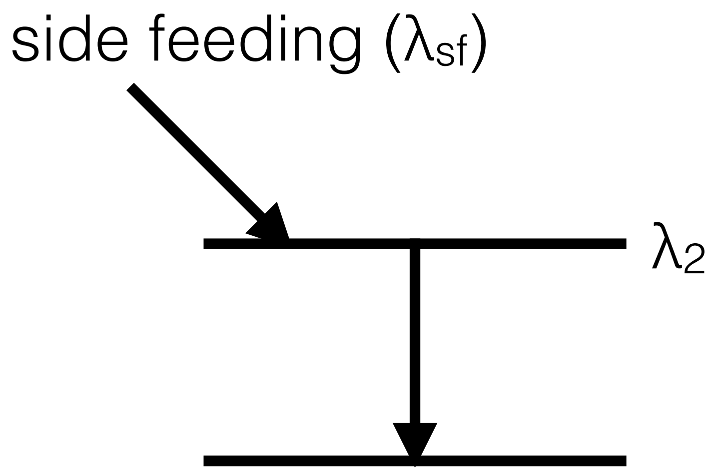

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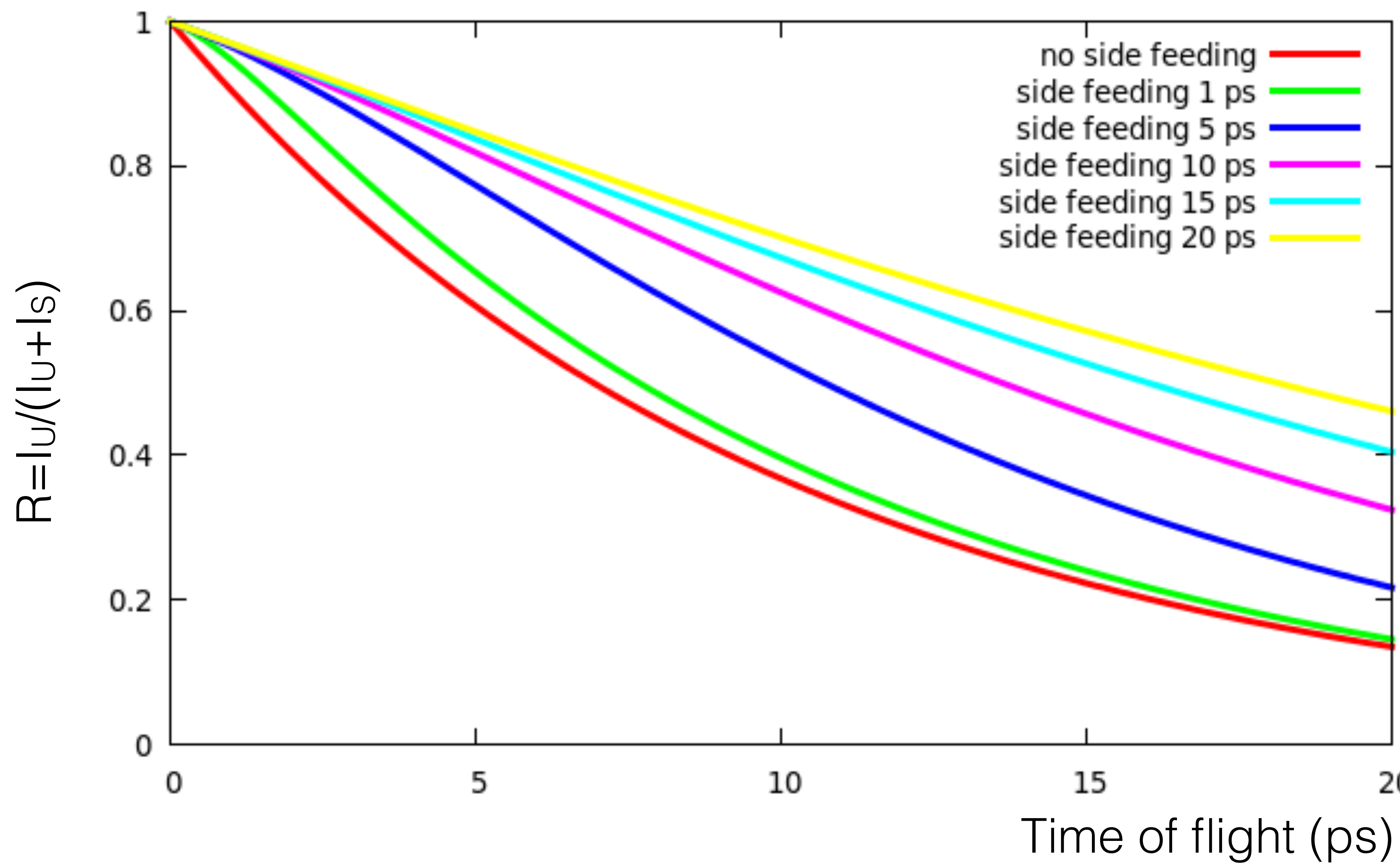

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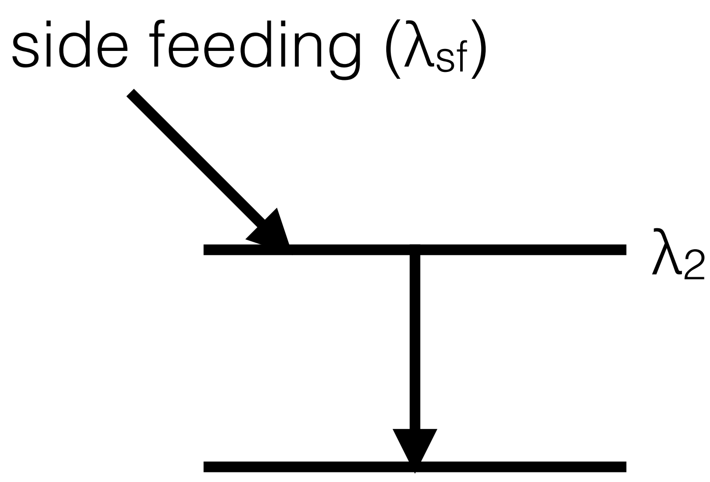

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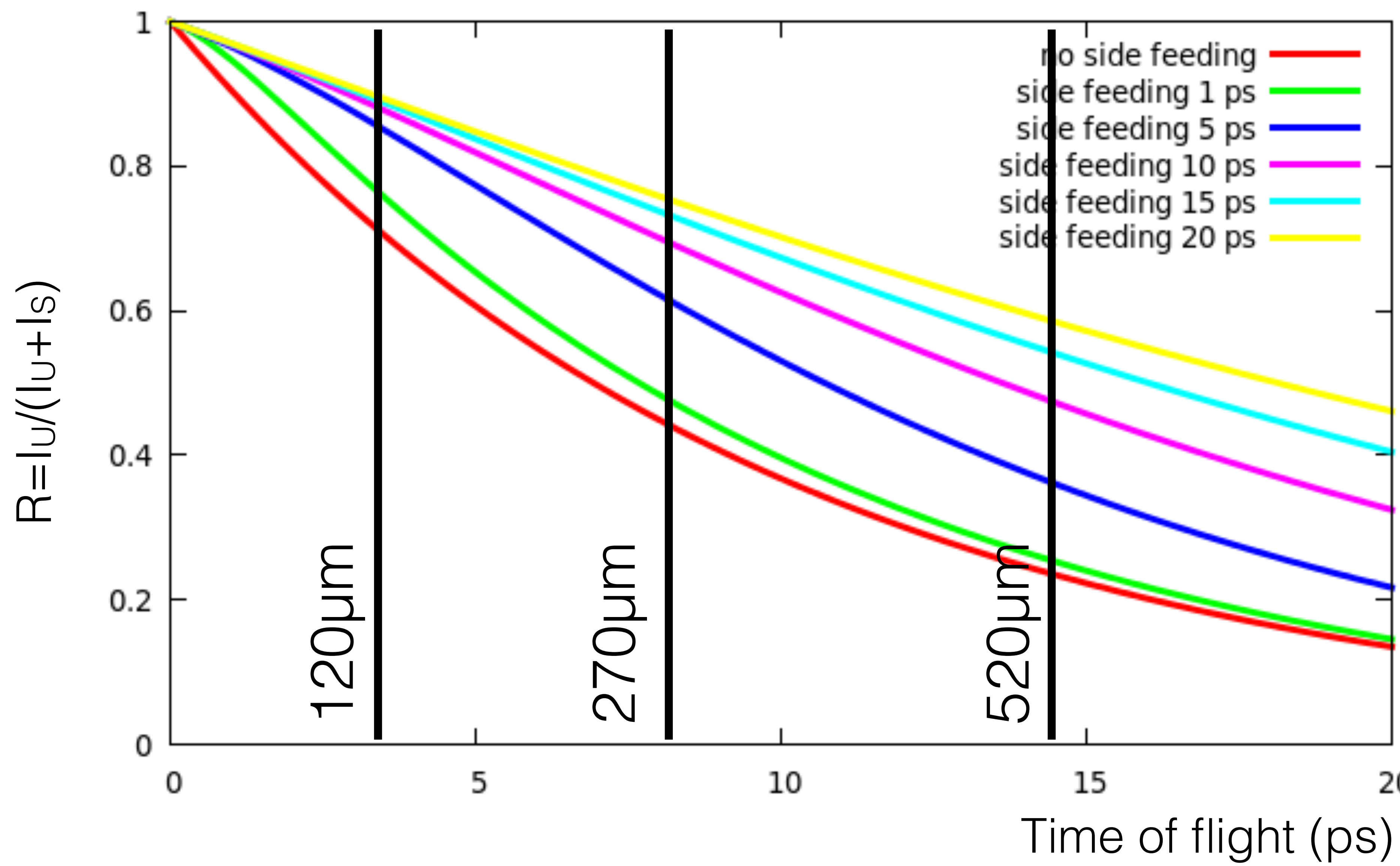

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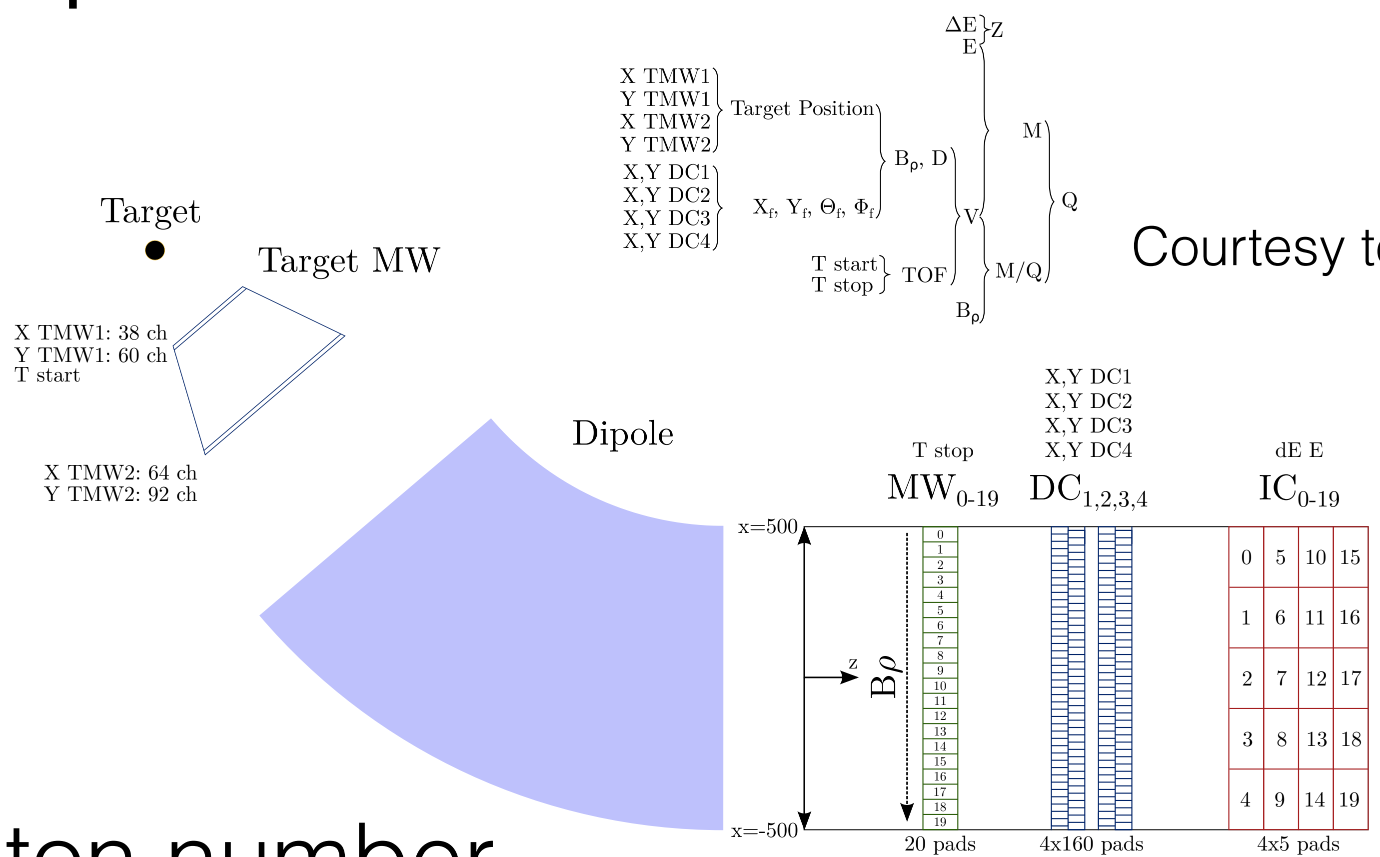
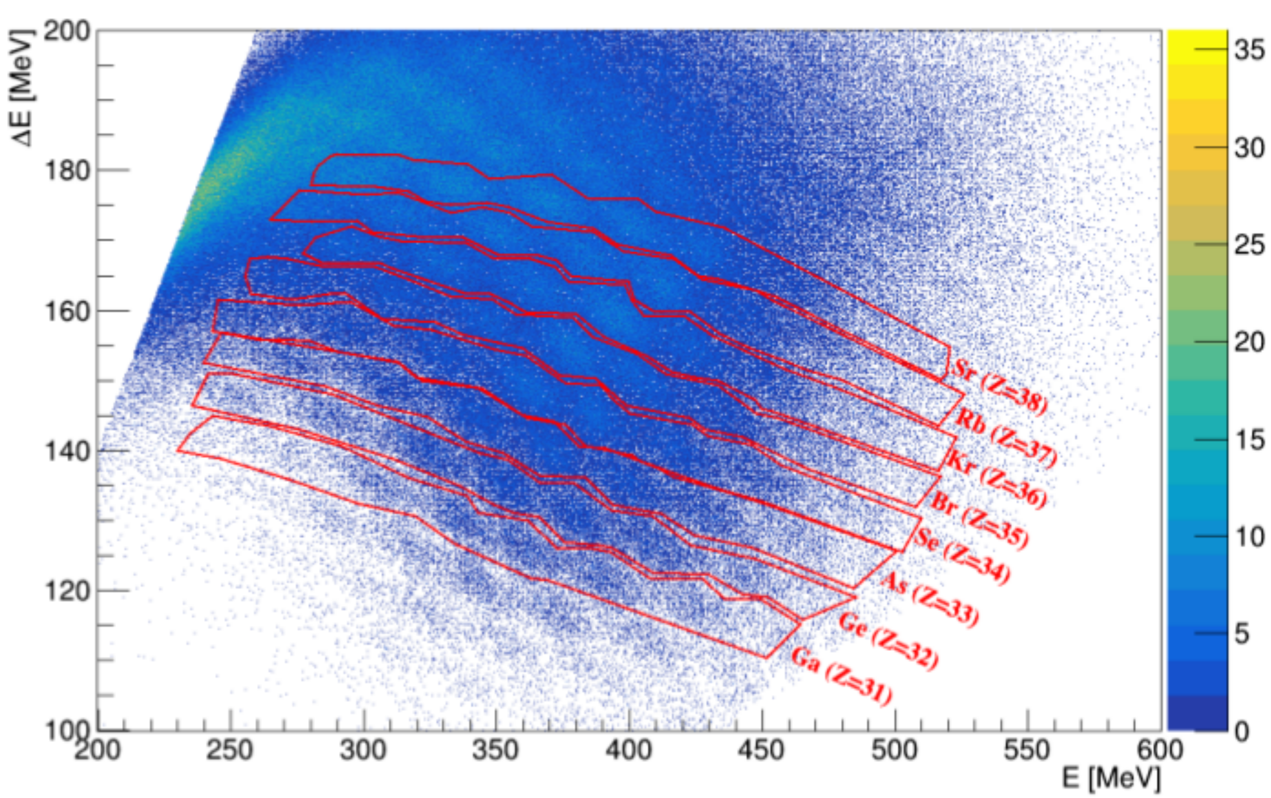
Fission products identification with VAMOS

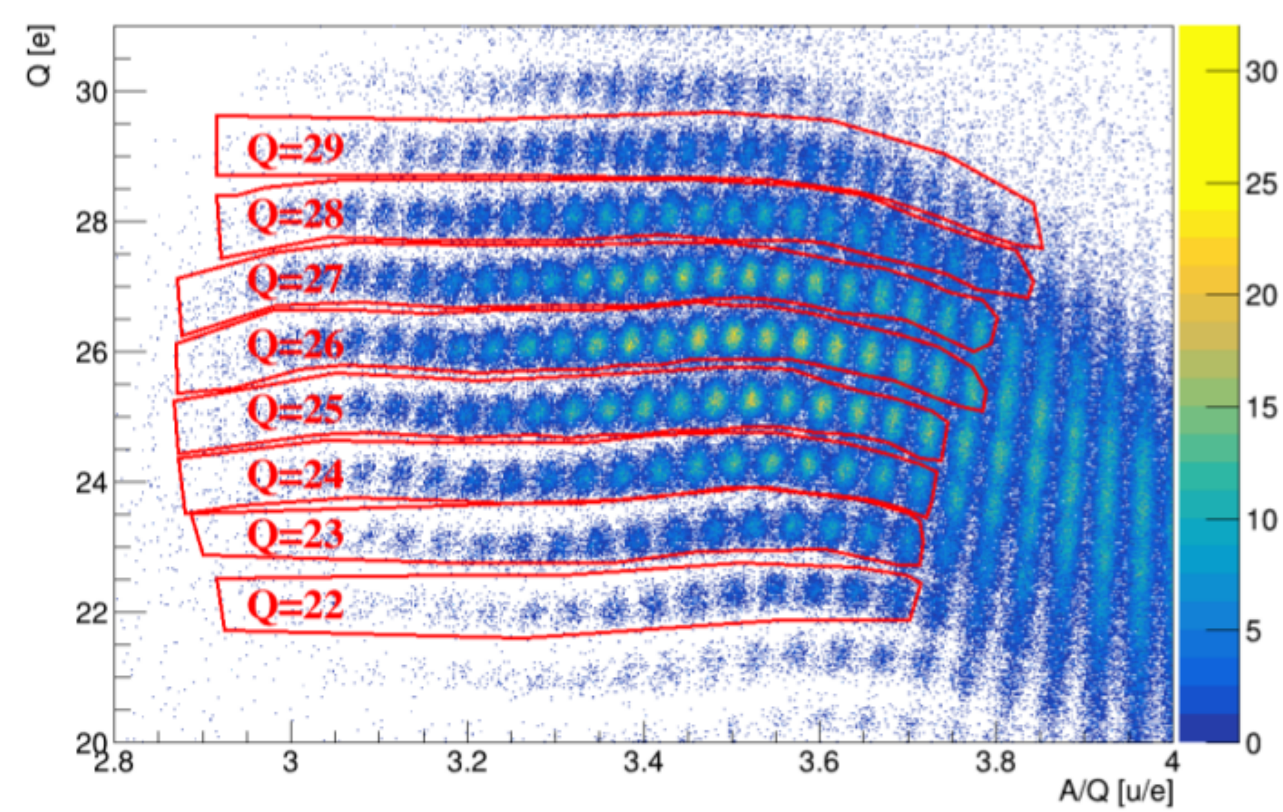


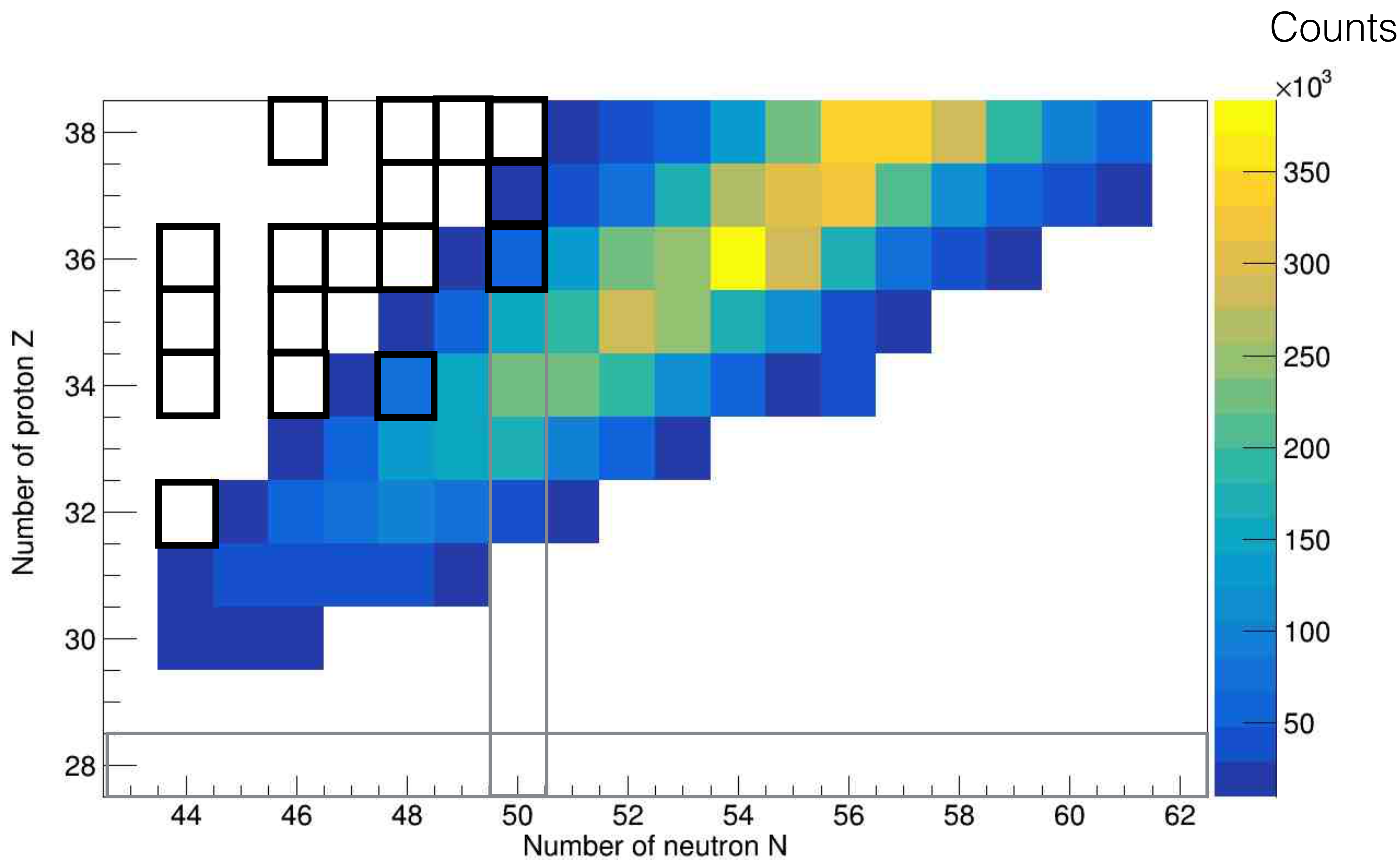
Courtesy to J. Dudouet

Proton number

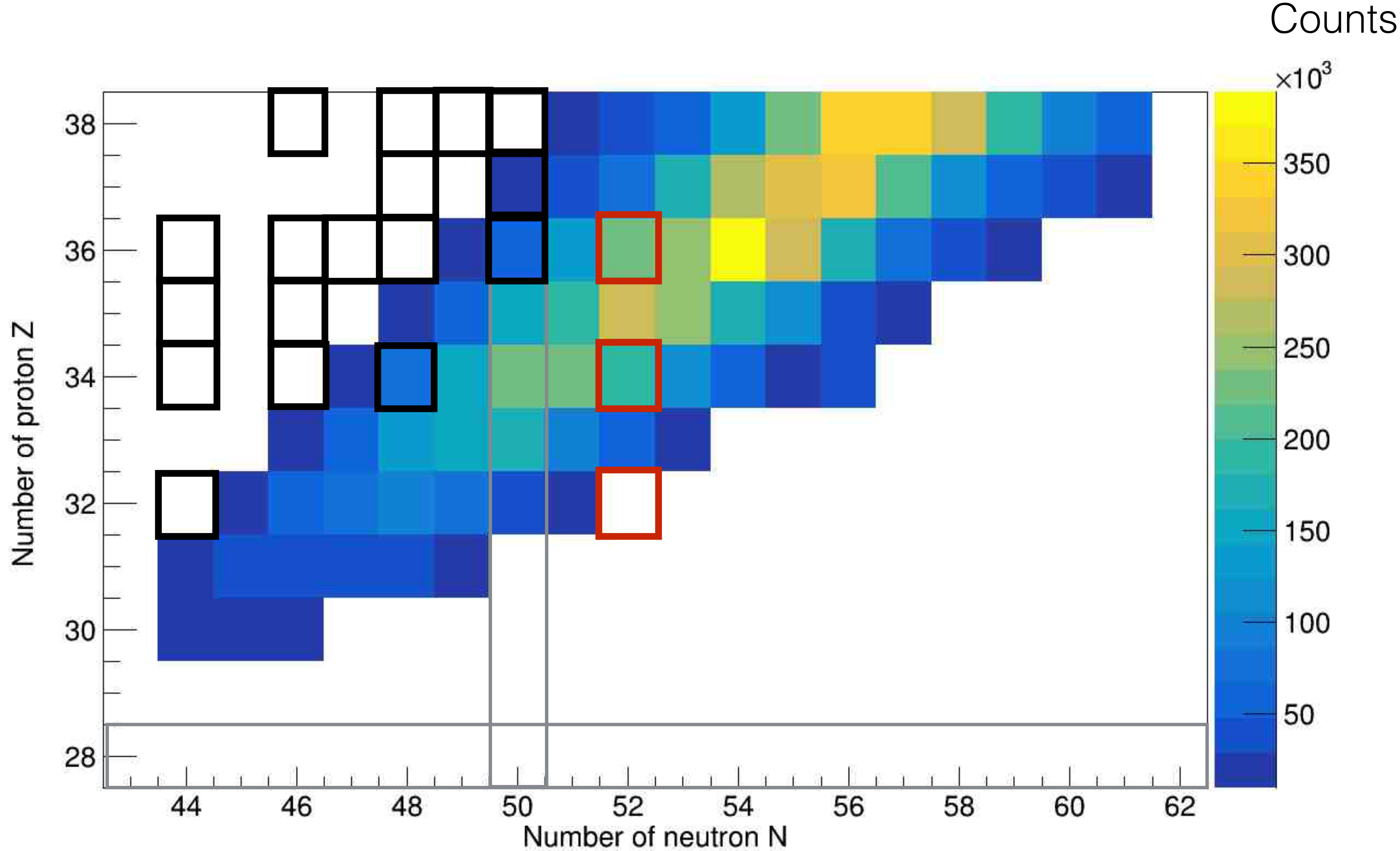
Mass







Number of ions identified with VAMOS as a function of the number of proton and neutron



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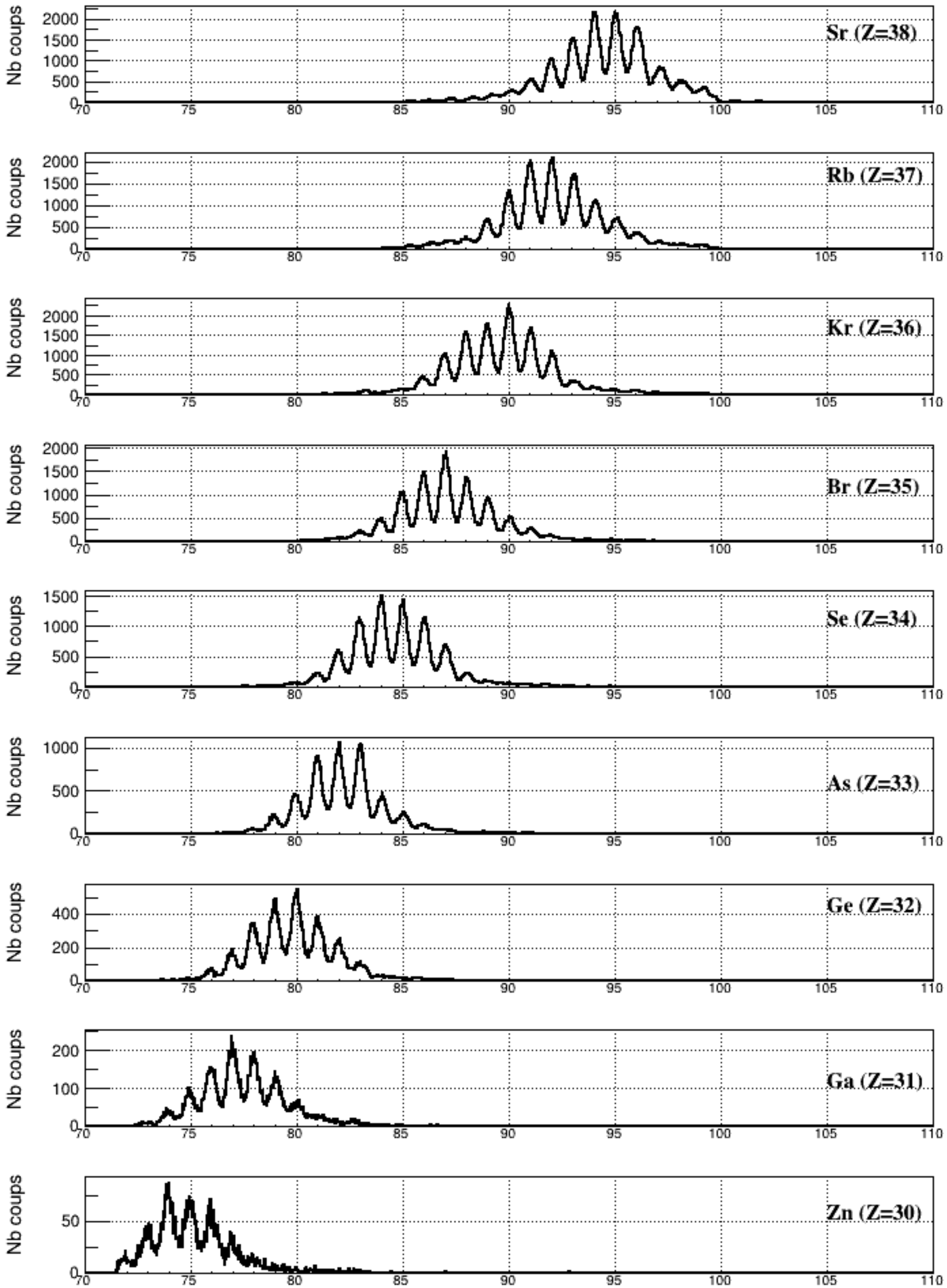

Mass spectra as a function of Z

FWHM = 0.6% at A = 86

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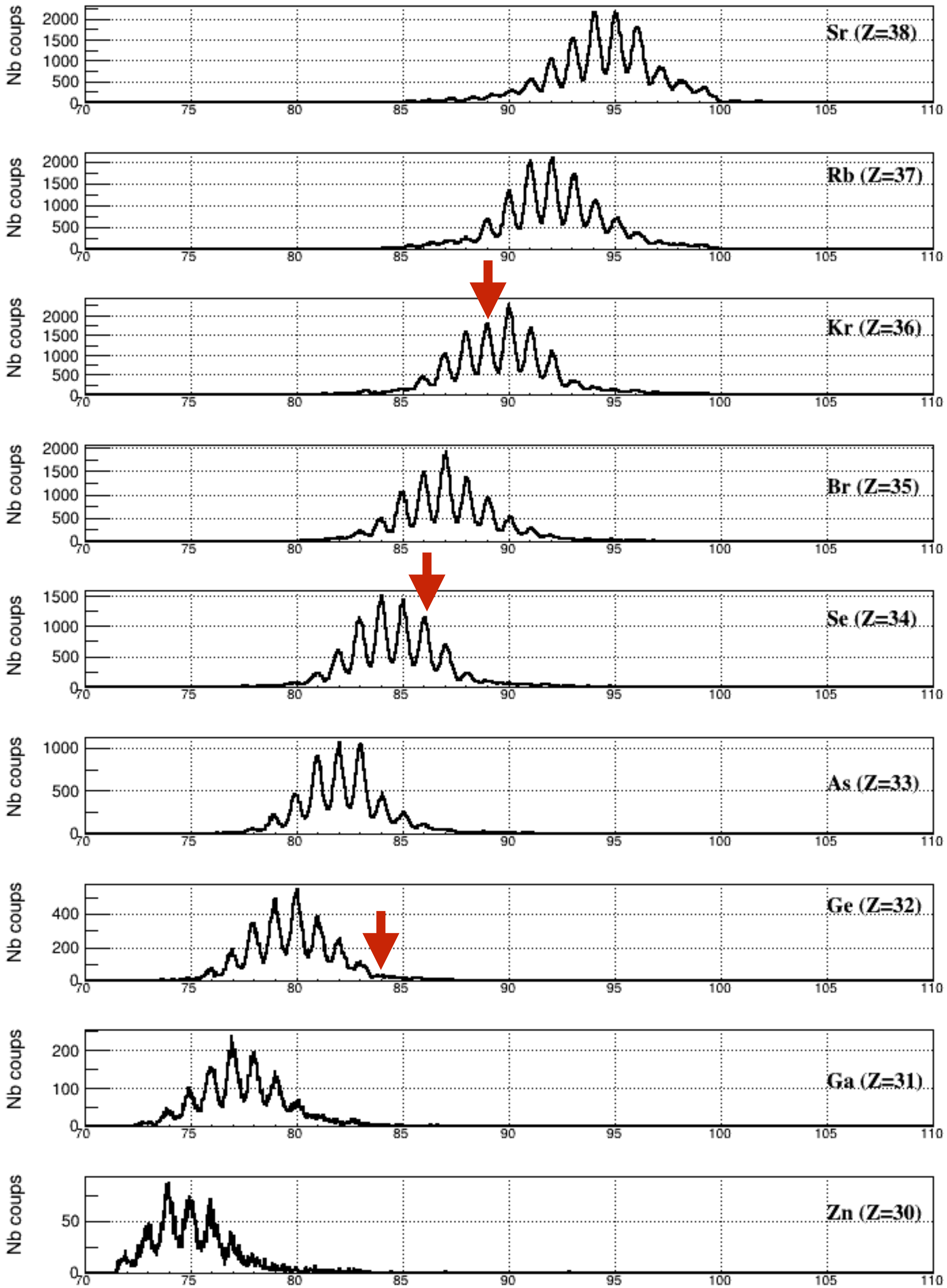

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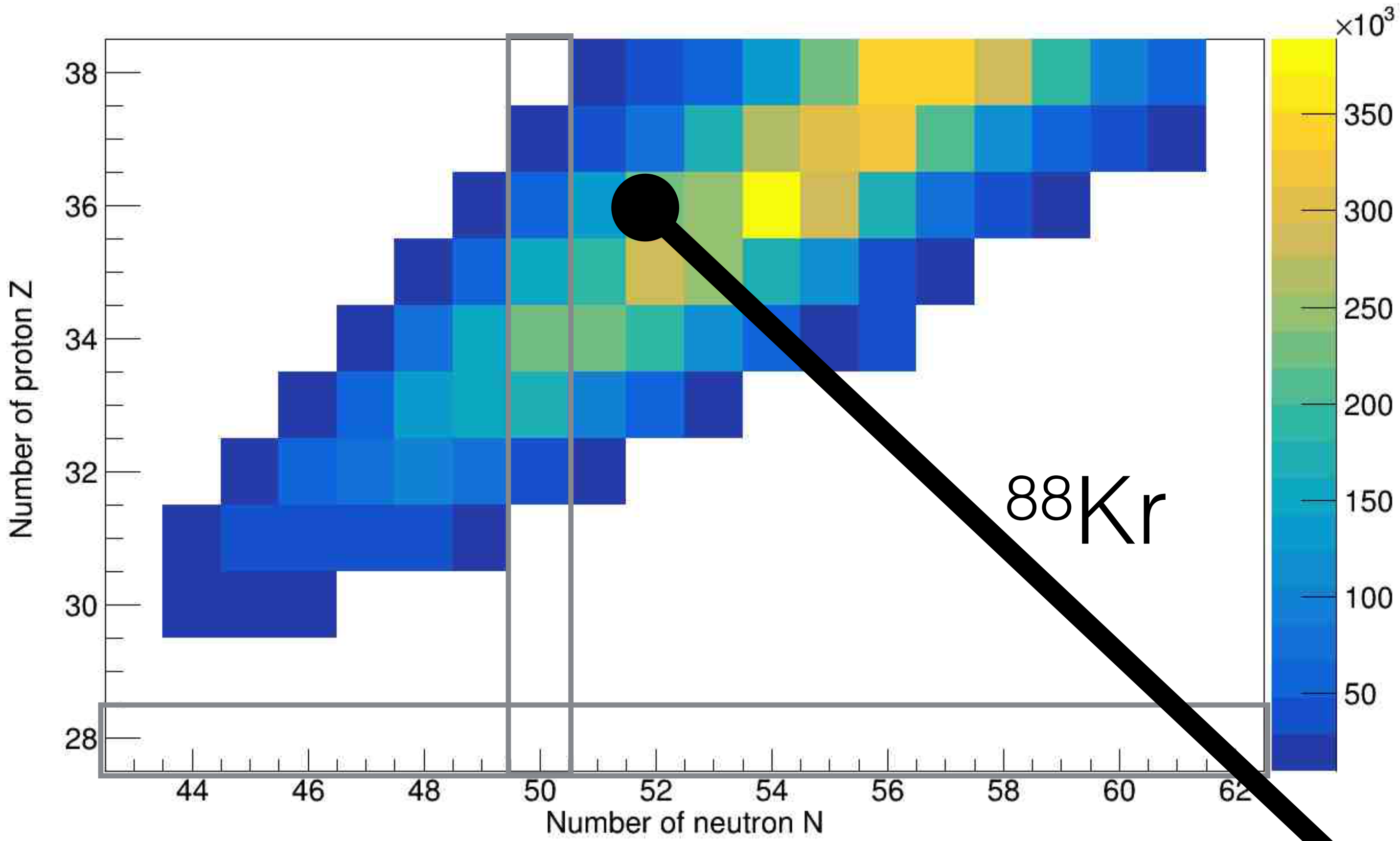
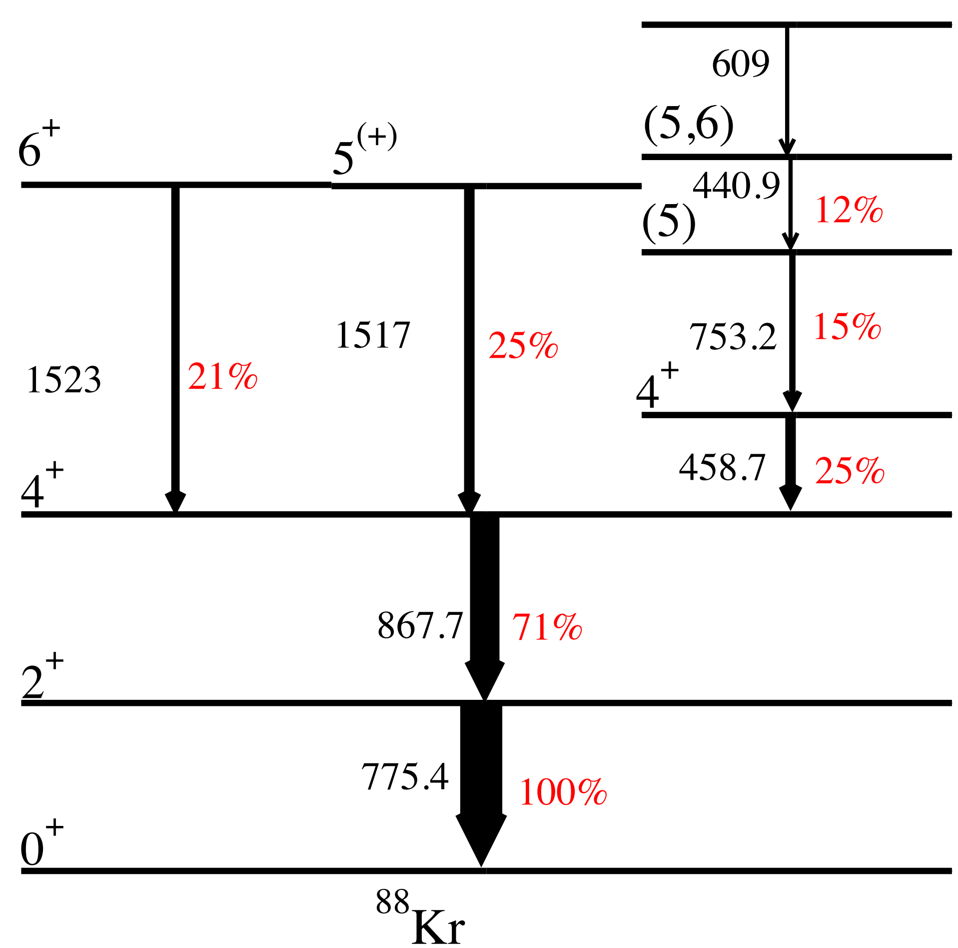
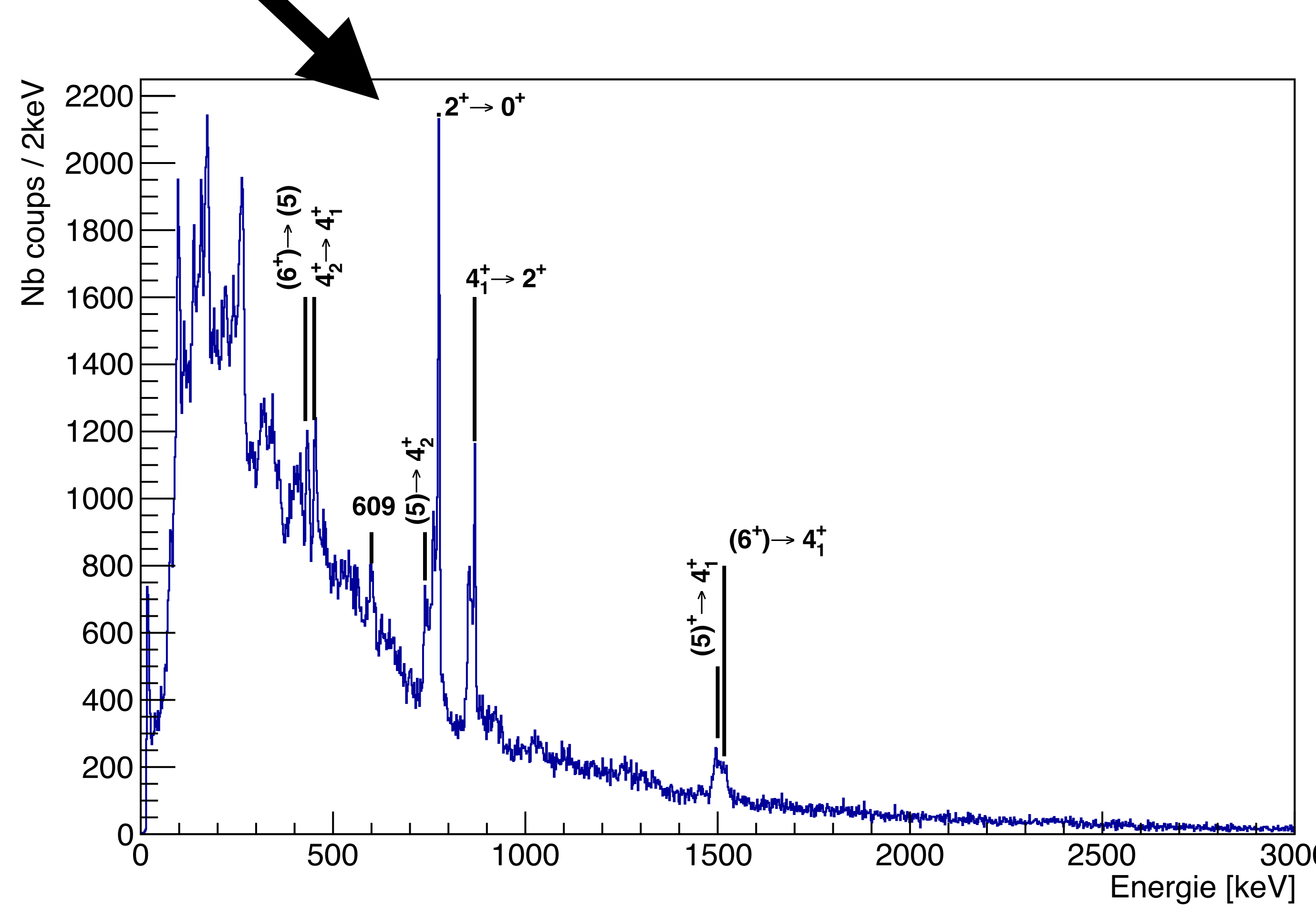


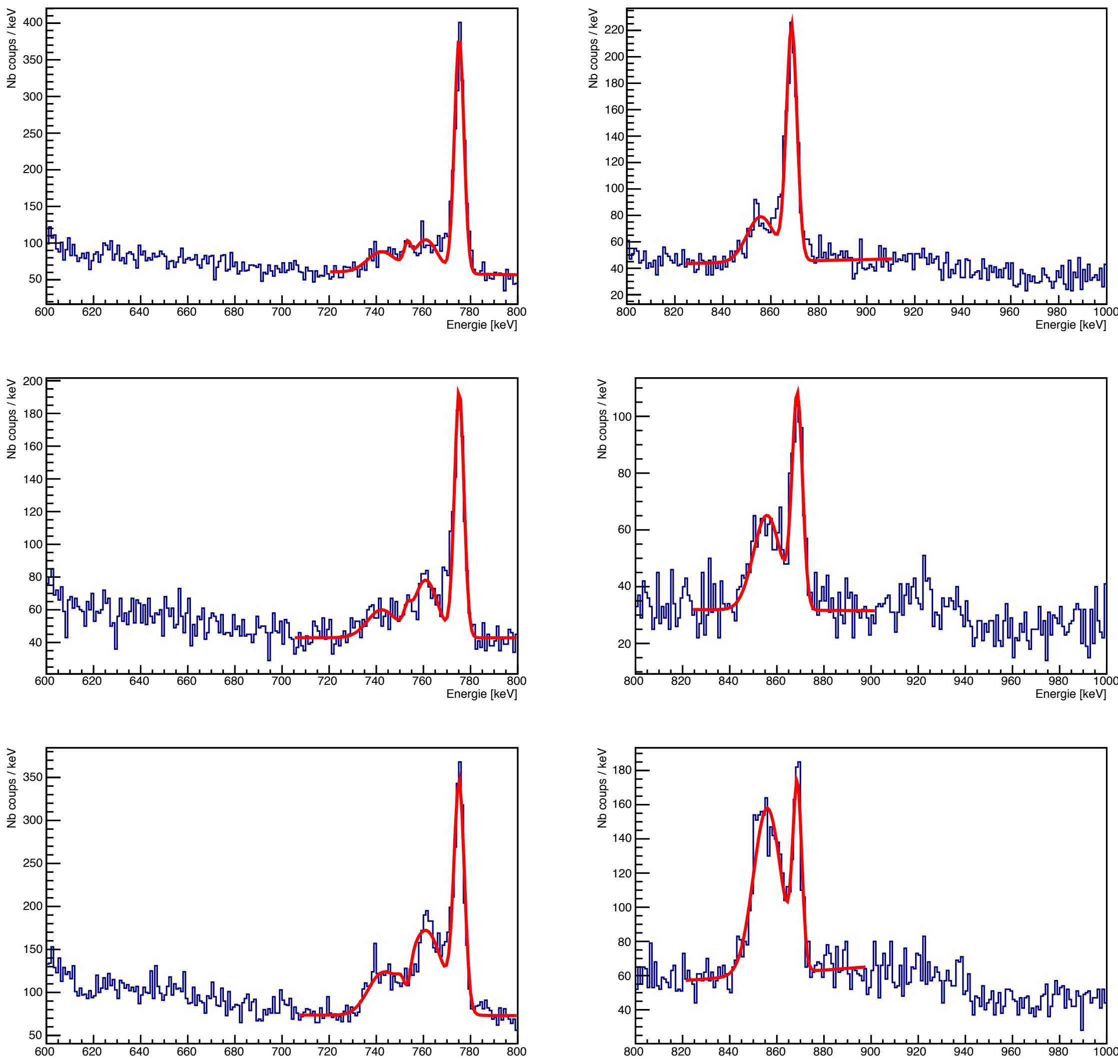
Sum of all distances
γ-spectrum





Life time measurement : ^{88}Kr

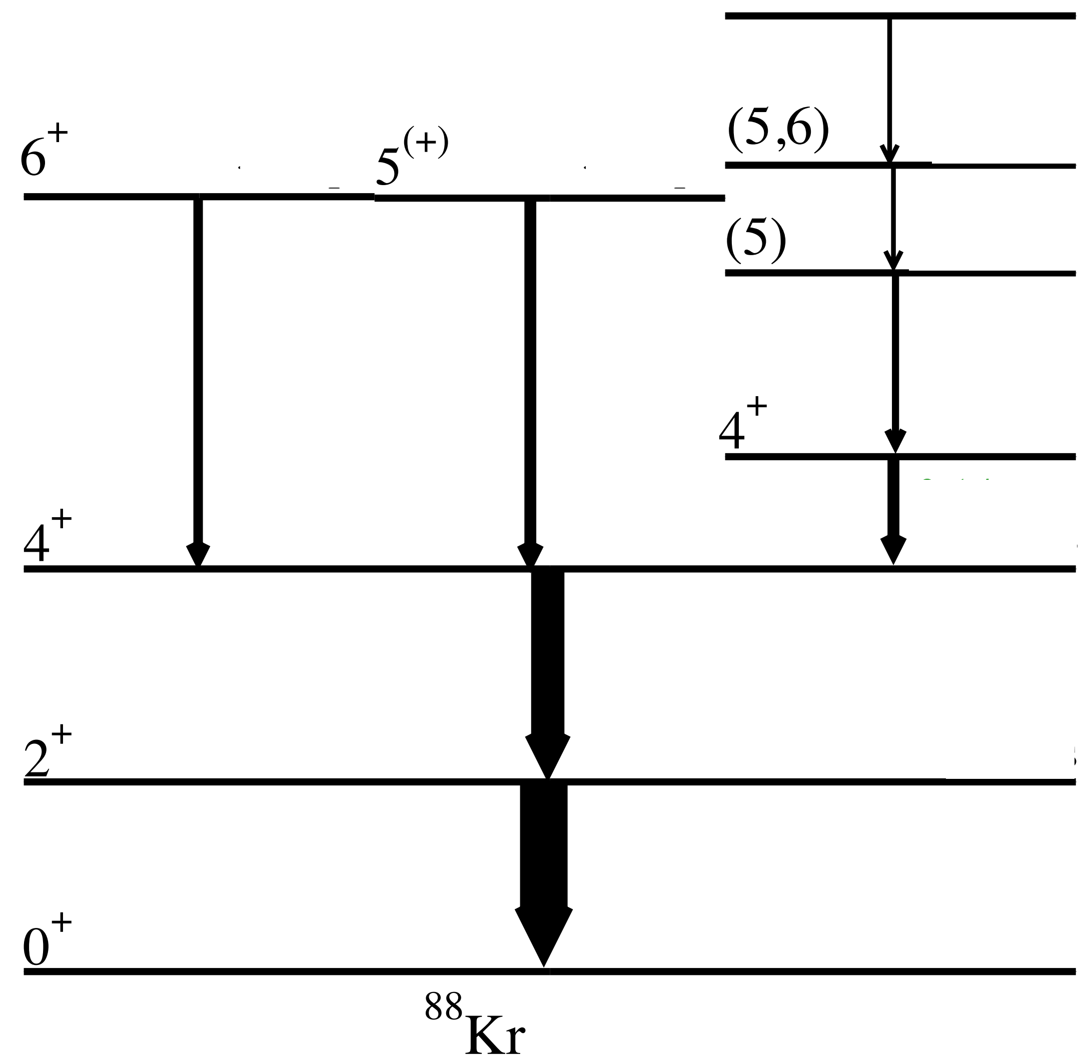
$2^+ \to 0^+$ | $4^+ \to 2^+$



120 µm

270 µm

520 µm



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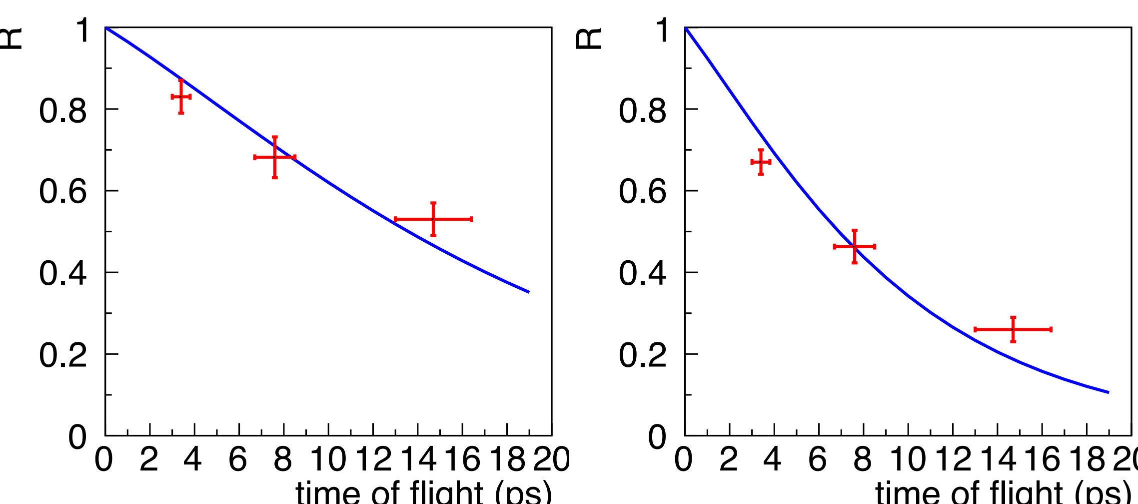

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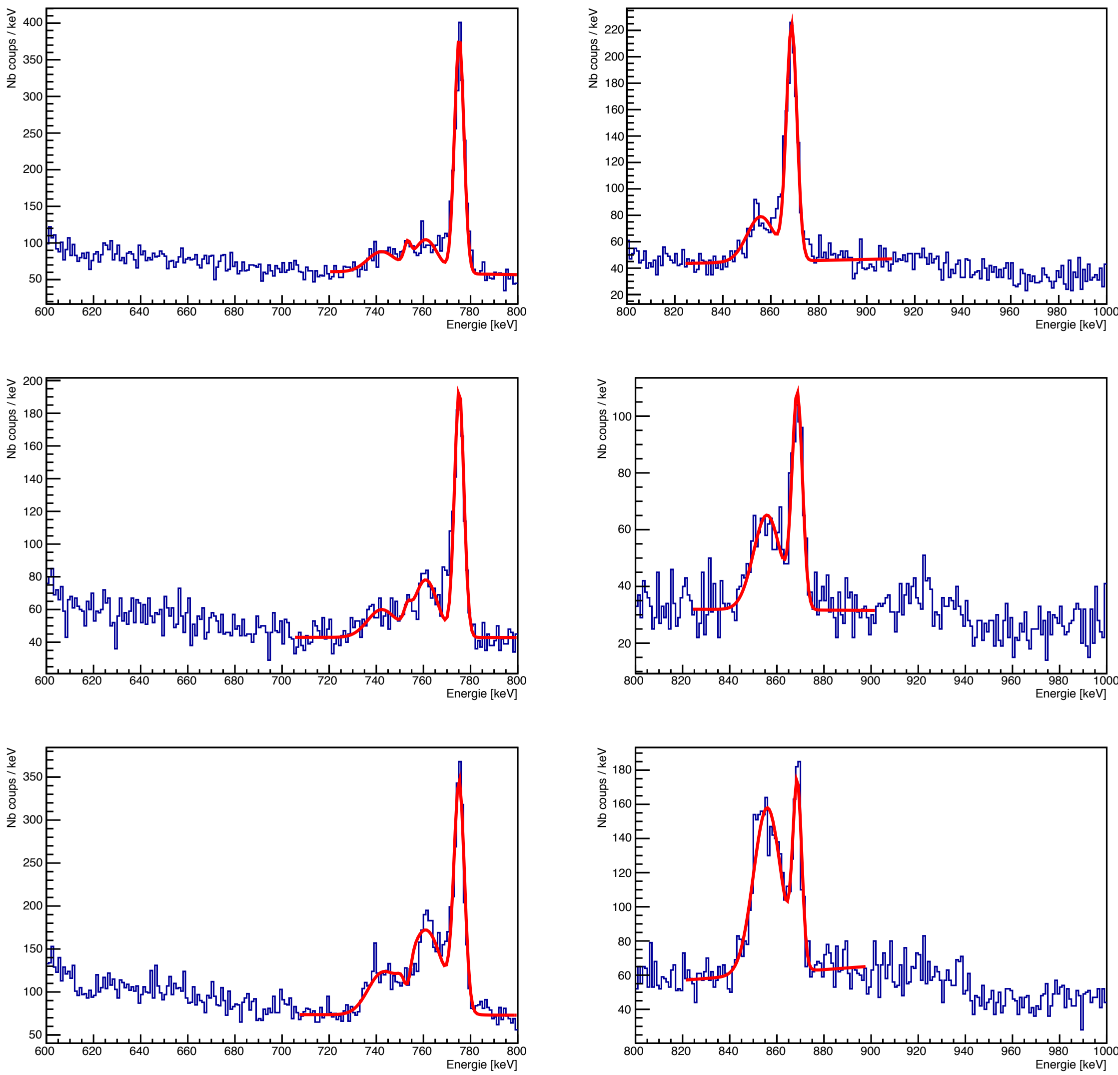

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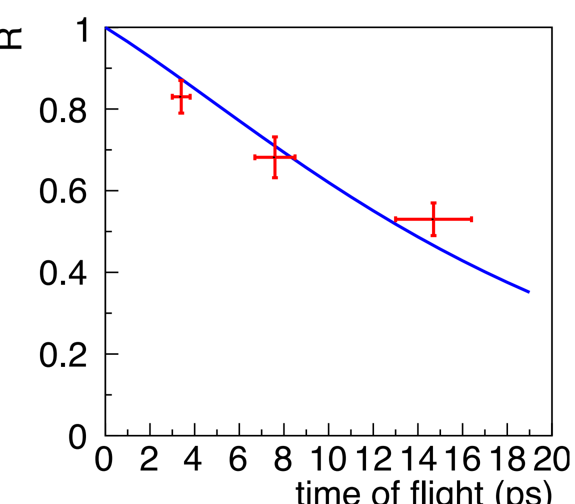
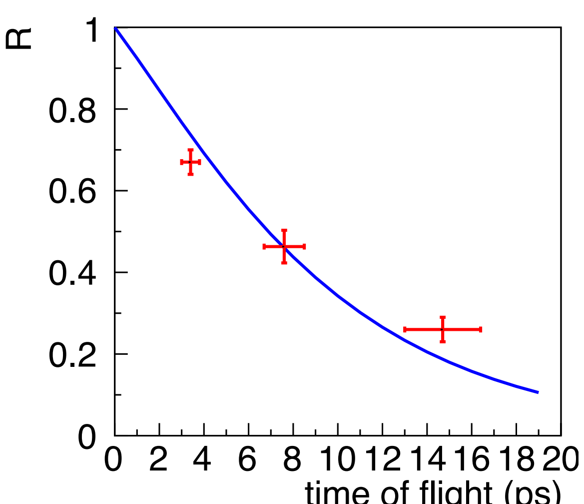
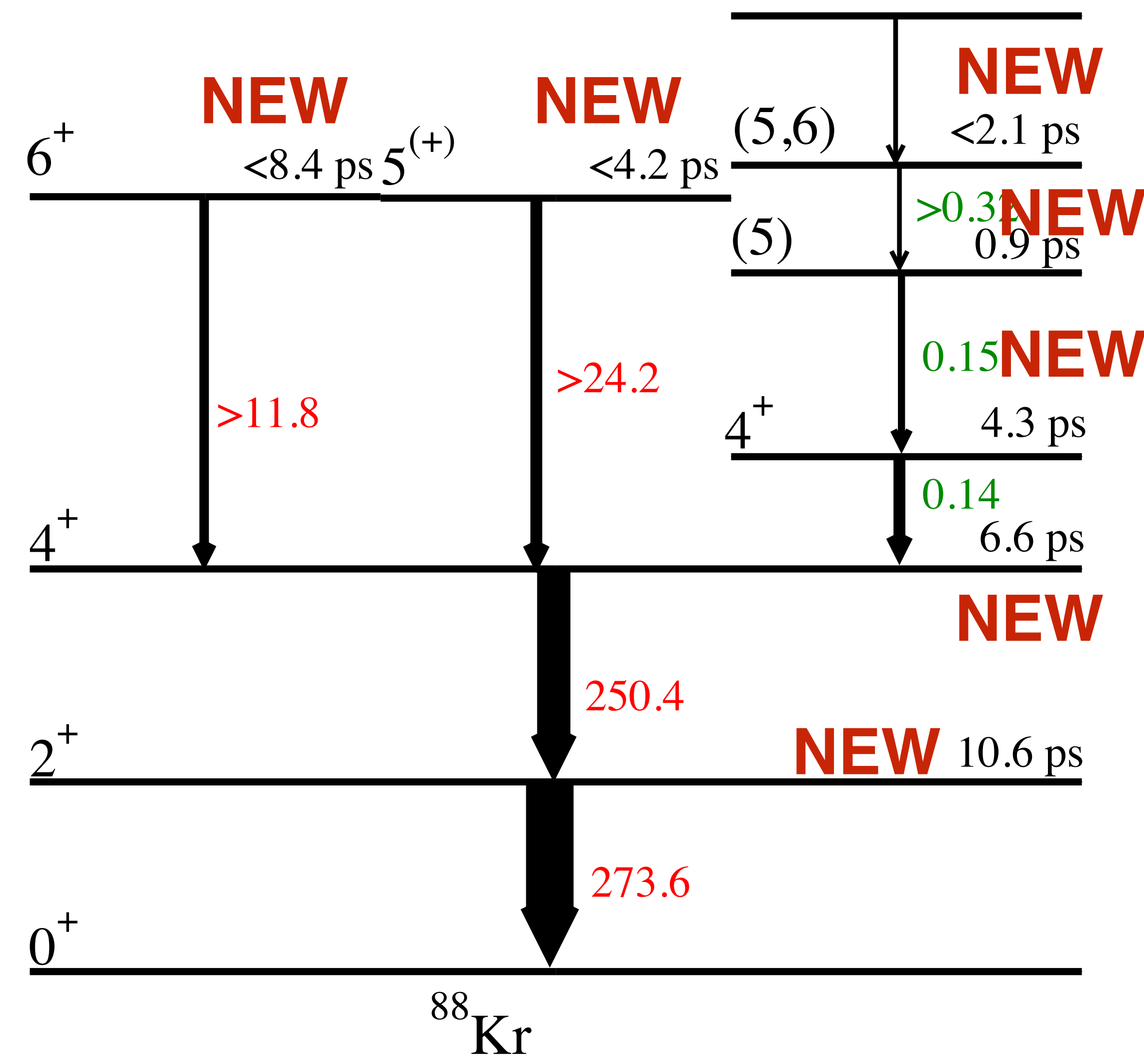


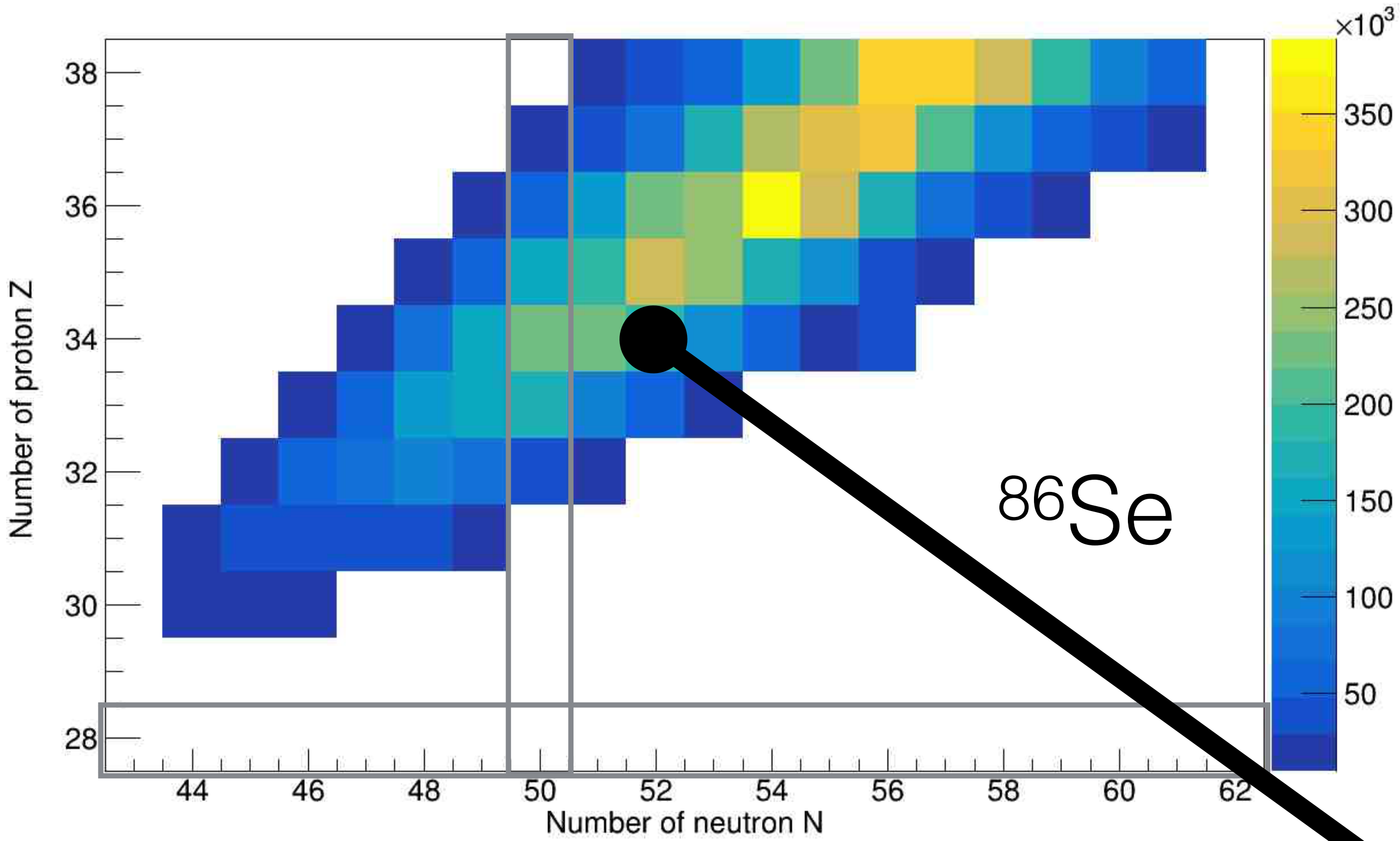
$4^+ \rightarrow 2^+$





B(E2)↓ (e^2fm^4)

B(M1)↓ (μ_N^2)



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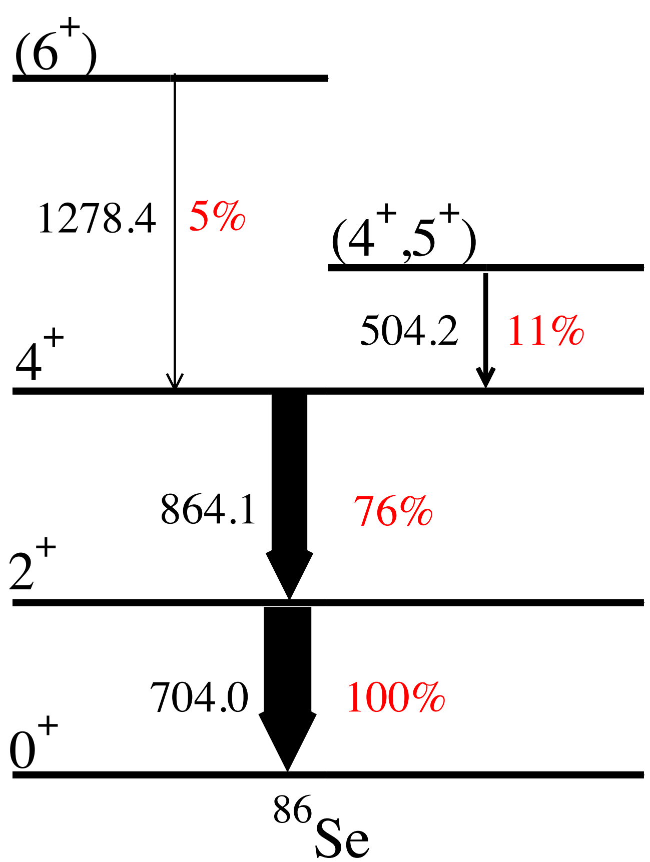
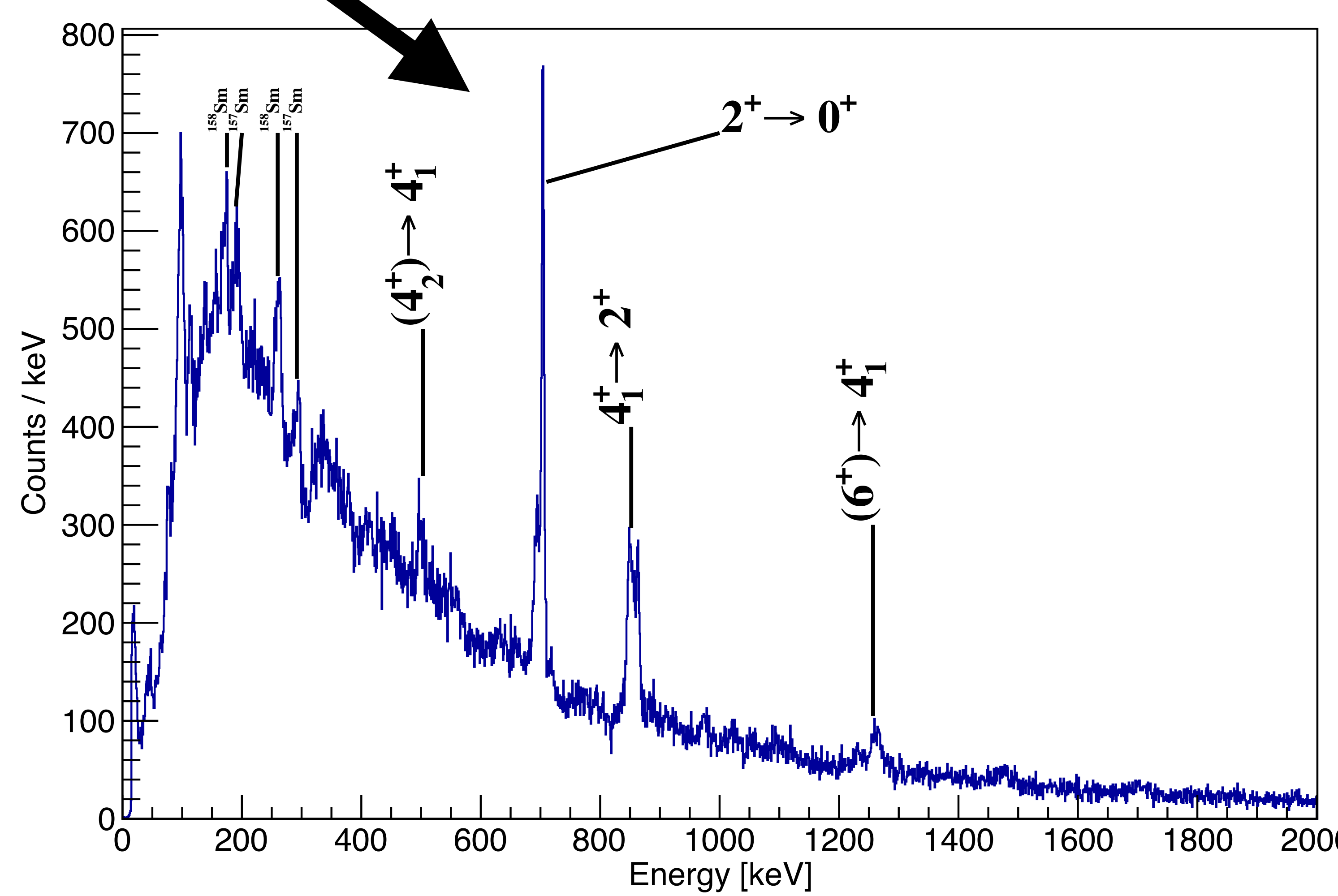
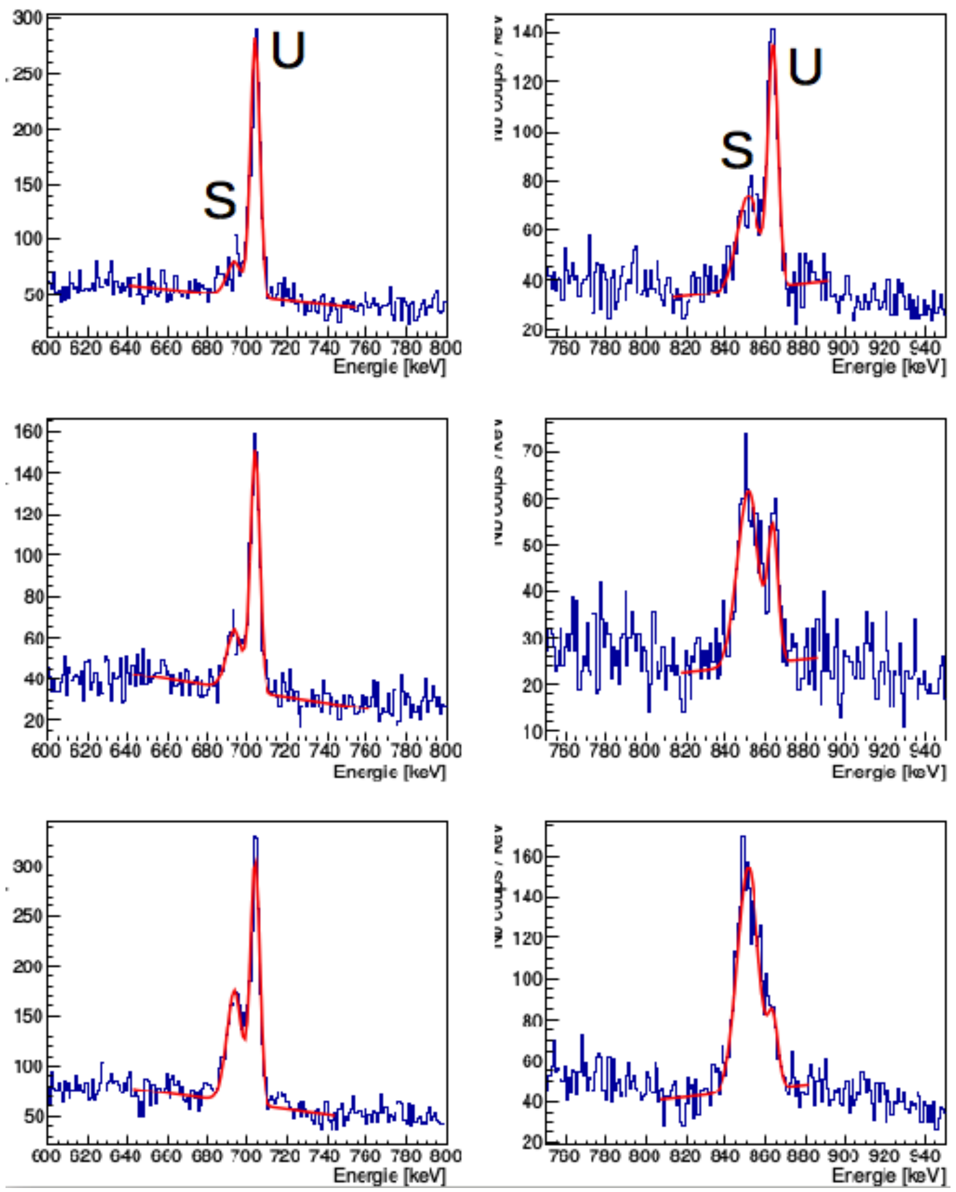




Life time measurement : ^{86}Se

$2^+ \rightarrow 0^+$ $4^+ \rightarrow 2^+$



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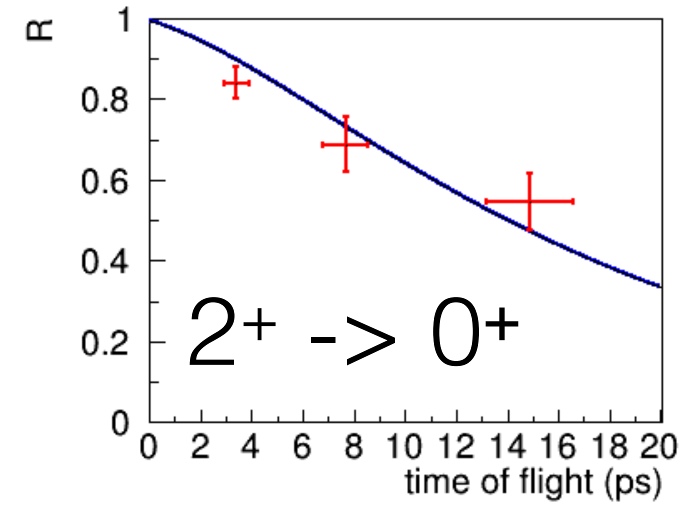
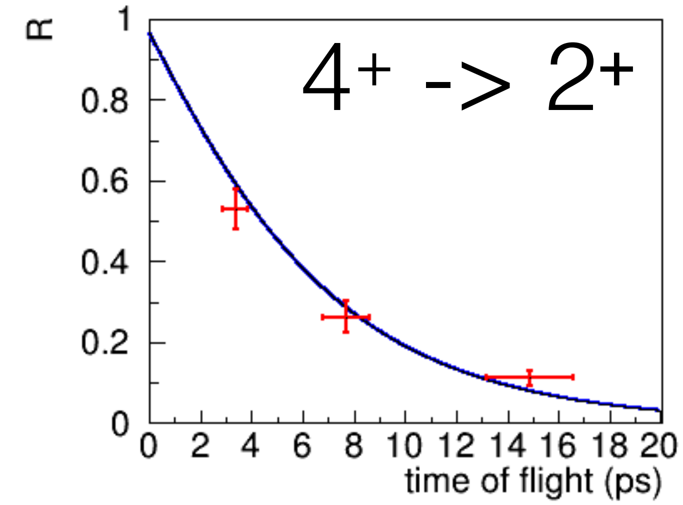
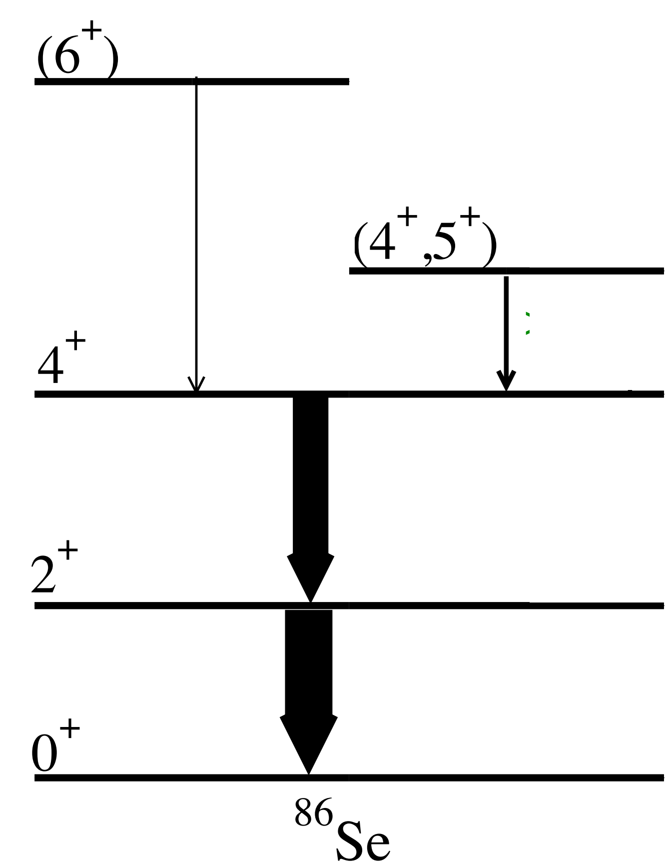
520 µm

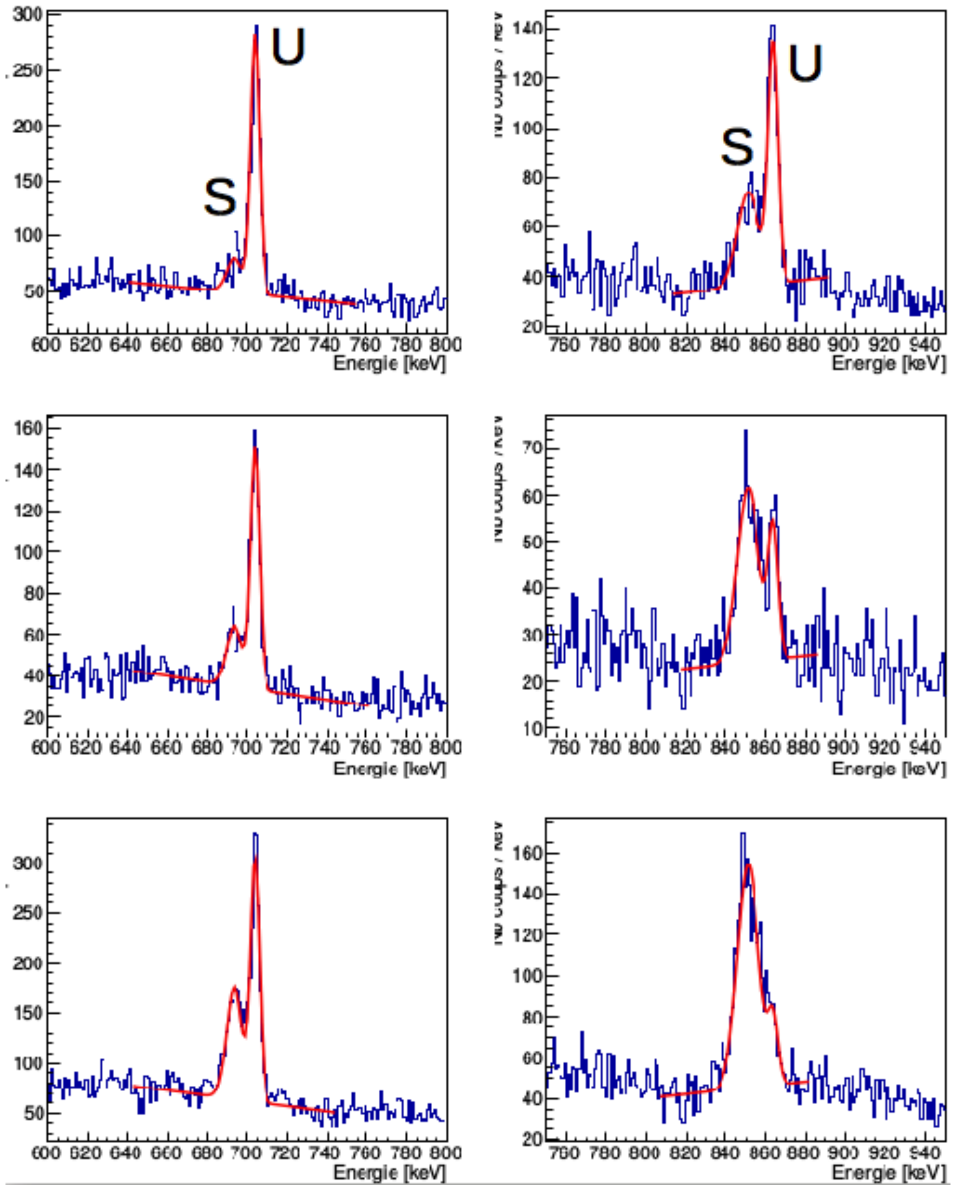






Life time measurement : ^{86}Se

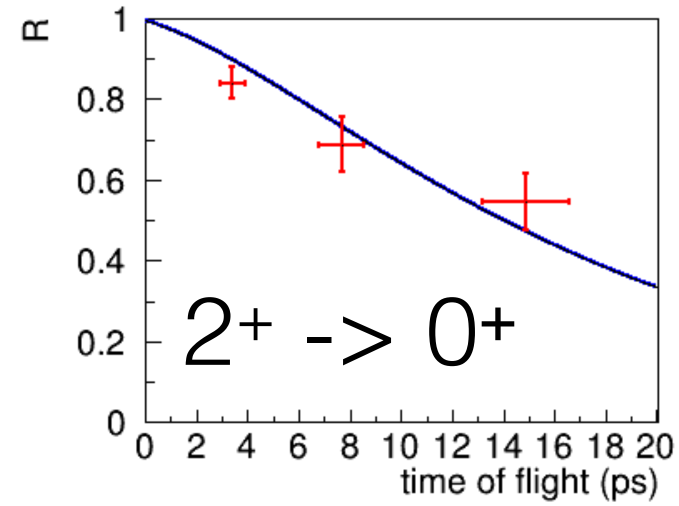
$2^+ \rightarrow 0^+$ $4^+ \rightarrow 2^+$

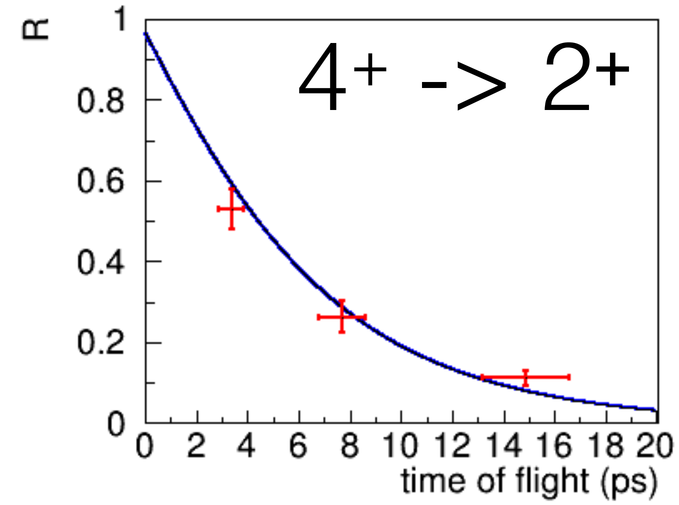


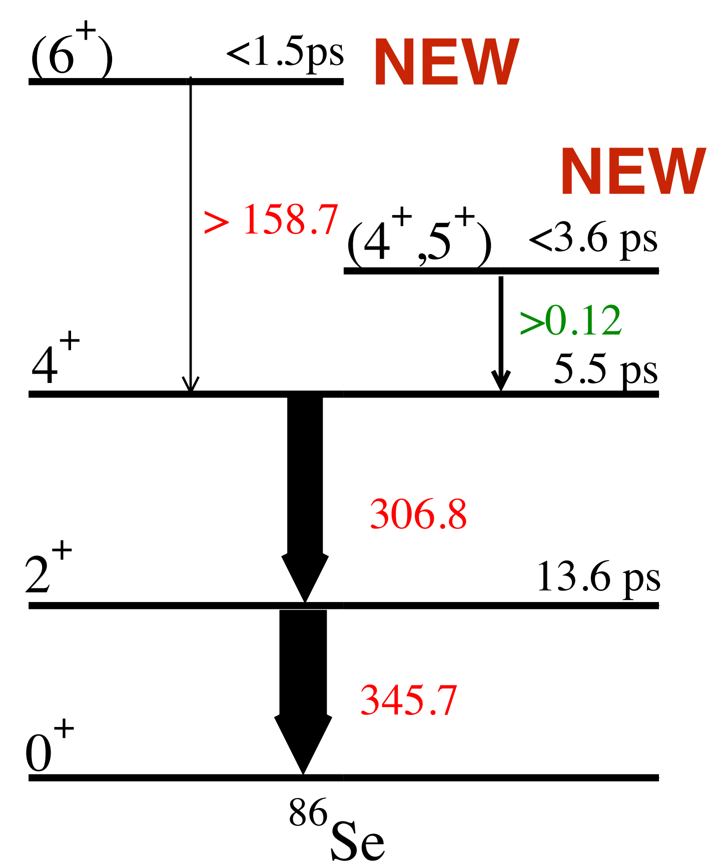
120 μm

270 μm

520 μm

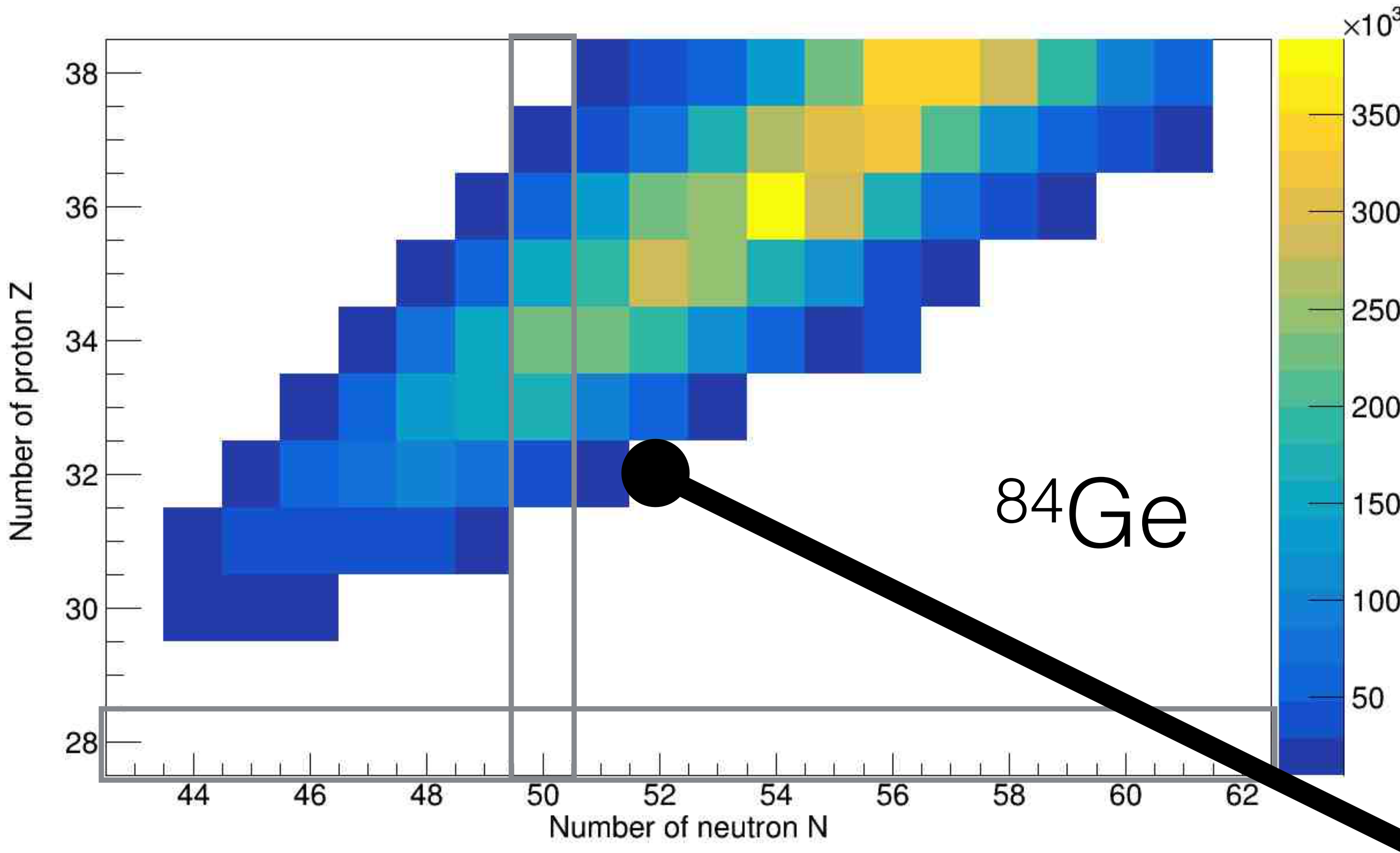




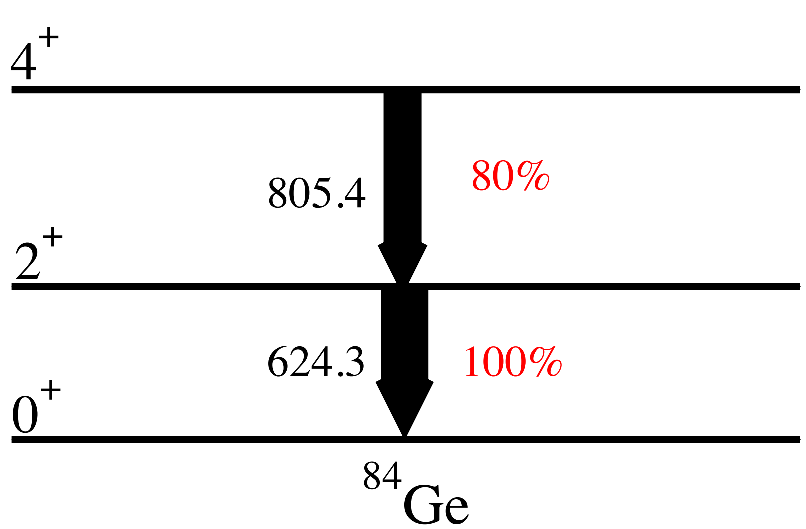


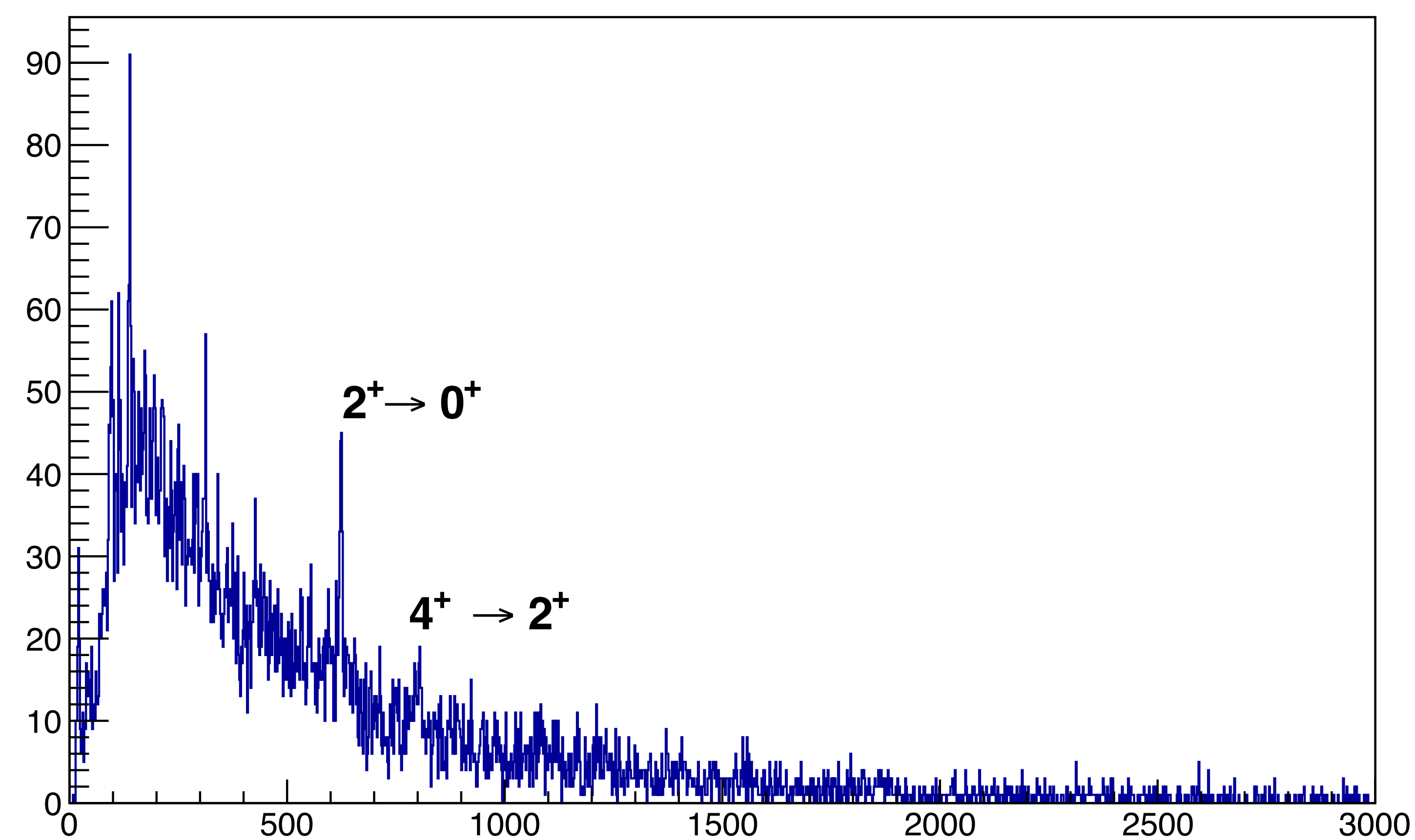
Consistant with J. Litzinger
PRC 92, 064322 (2015)
AGATA campaign at LNL

B(E2)↓ (e^2fm^4)
B(M1)↓ (μ_N^2)



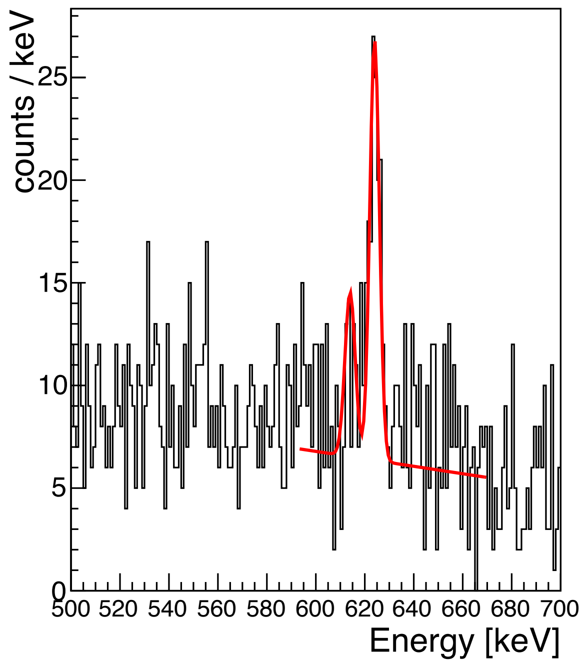
Sum of all distances
γ-spectrum

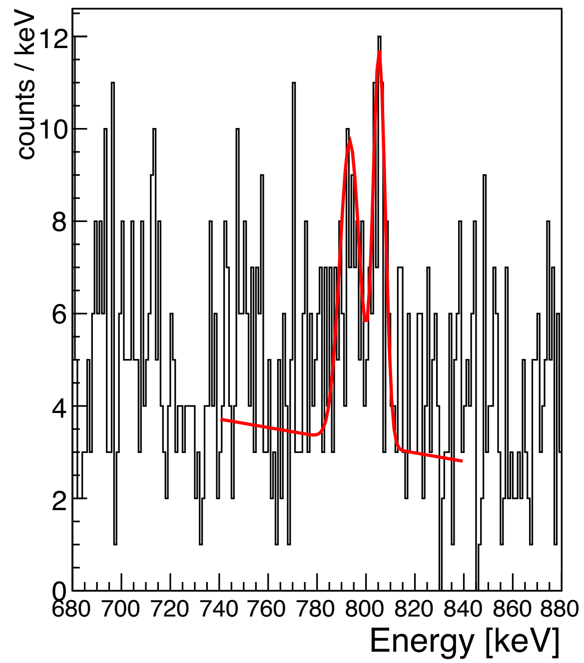




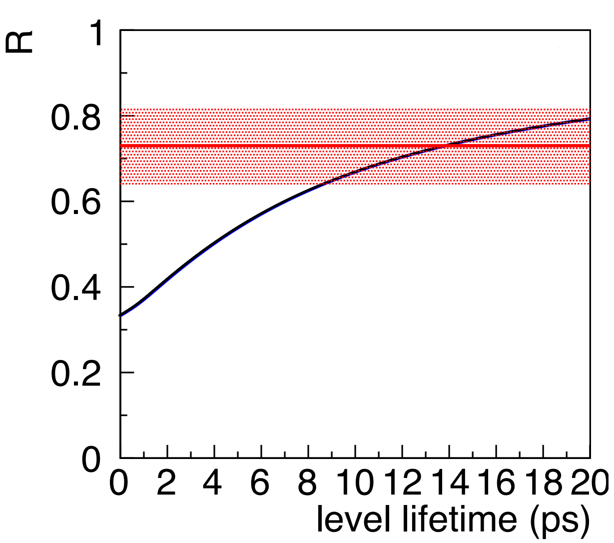
Life time measurement : ^{84}Ge

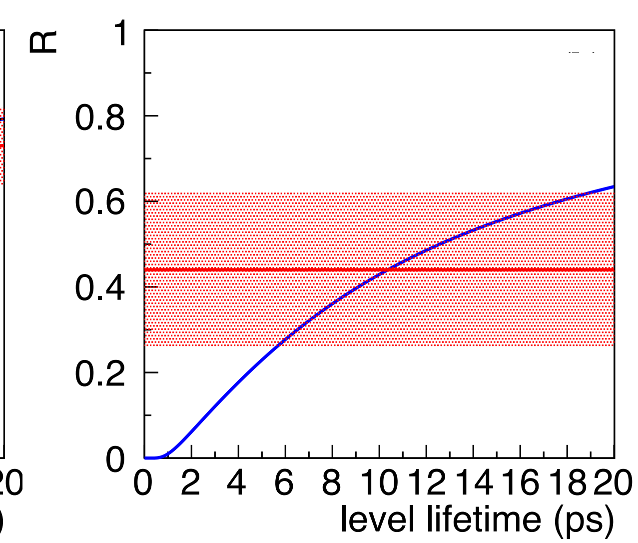
Techinics used by J. Litzinger in PRC 92, 064322 (2015)

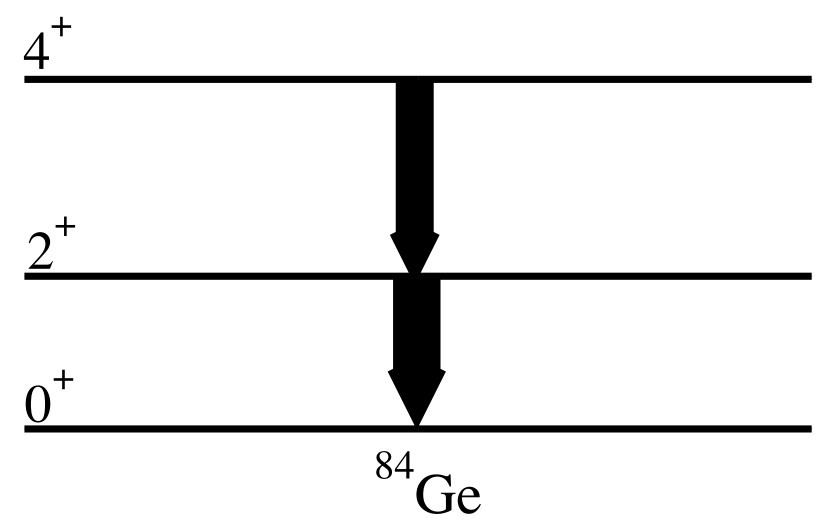




$$R_{\text{sum}} = \frac{\sum_{j=1}^{n} I_{Dj}}{\sum_{j=1}^{n} I_{Dj} + \sum_{j=1}^{n} I_{Tj}} = \sum_{j=1}^{n} n_j R(x_j),$$







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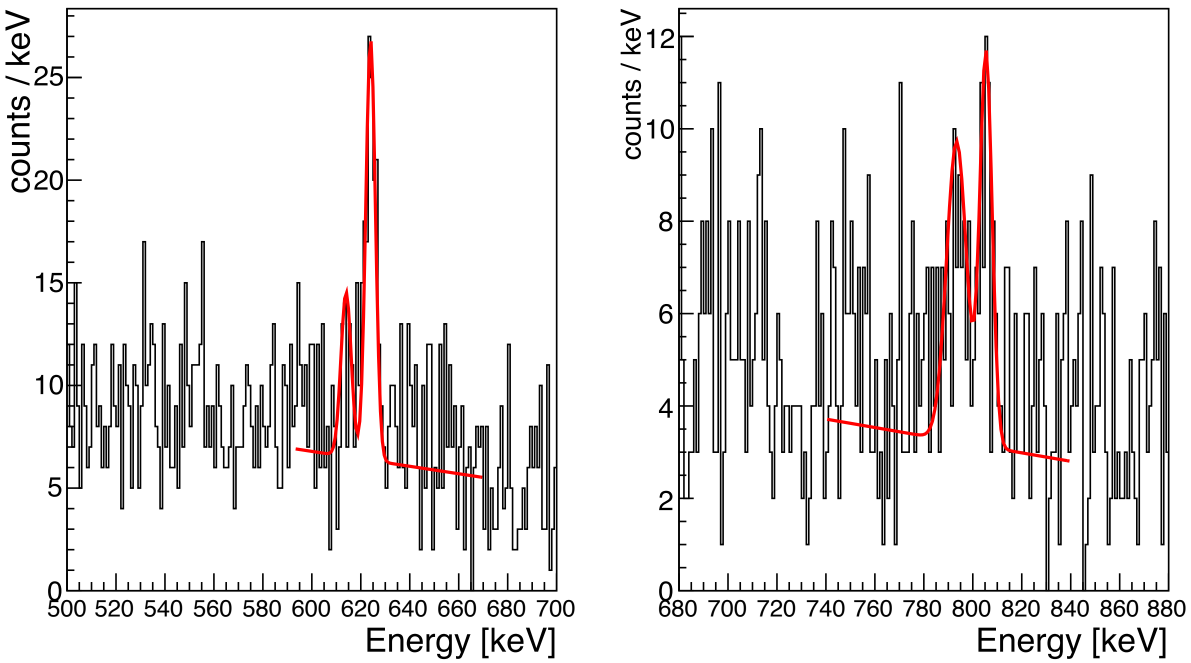

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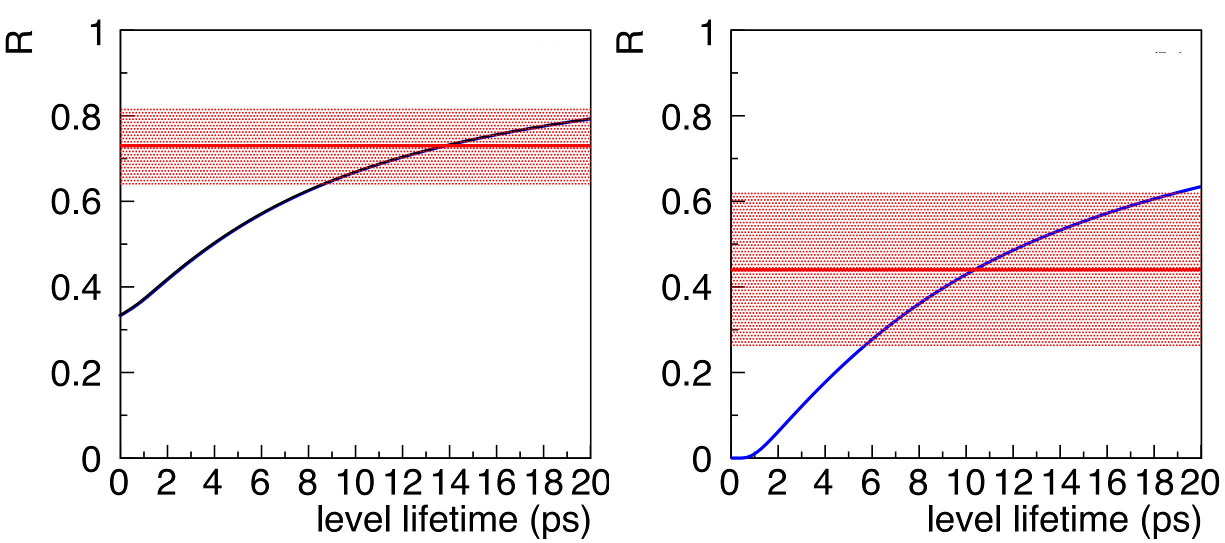

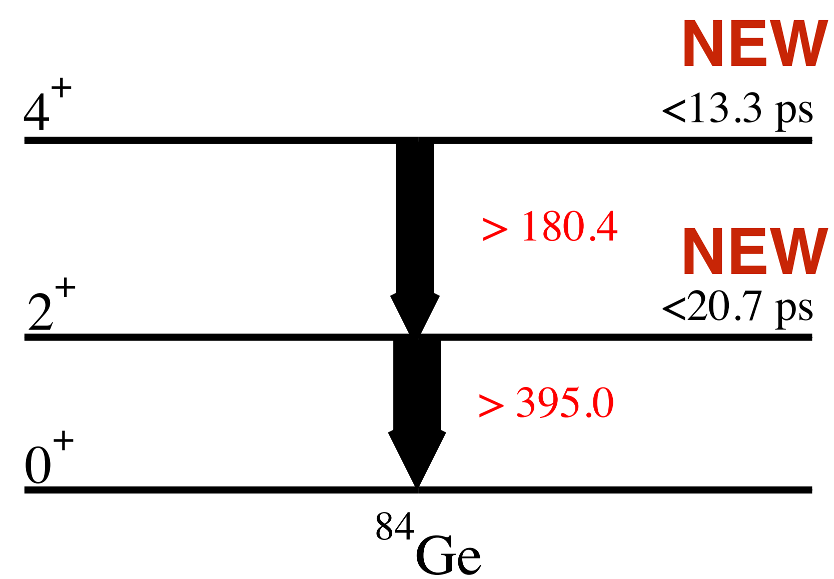

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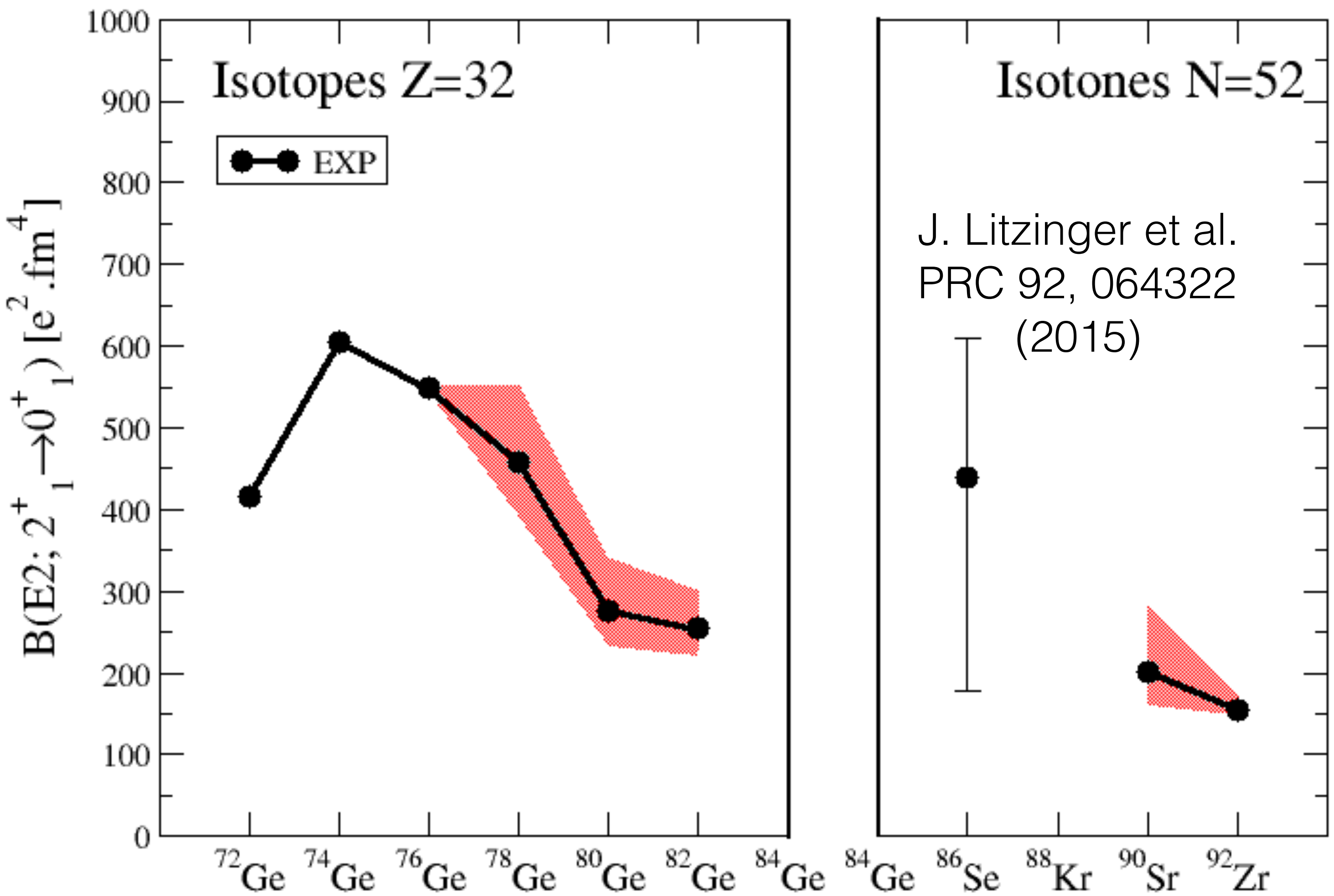
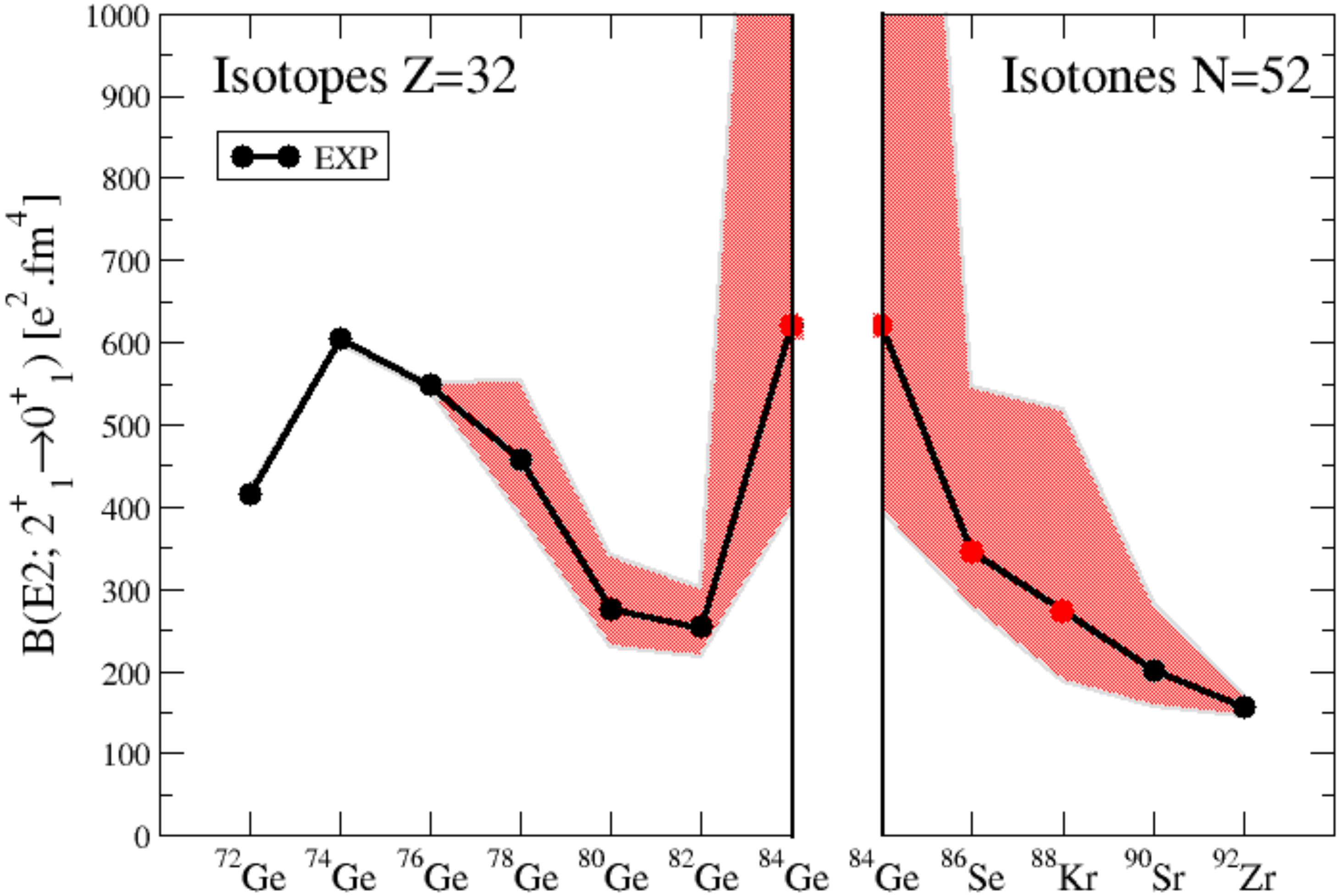
Interpretation



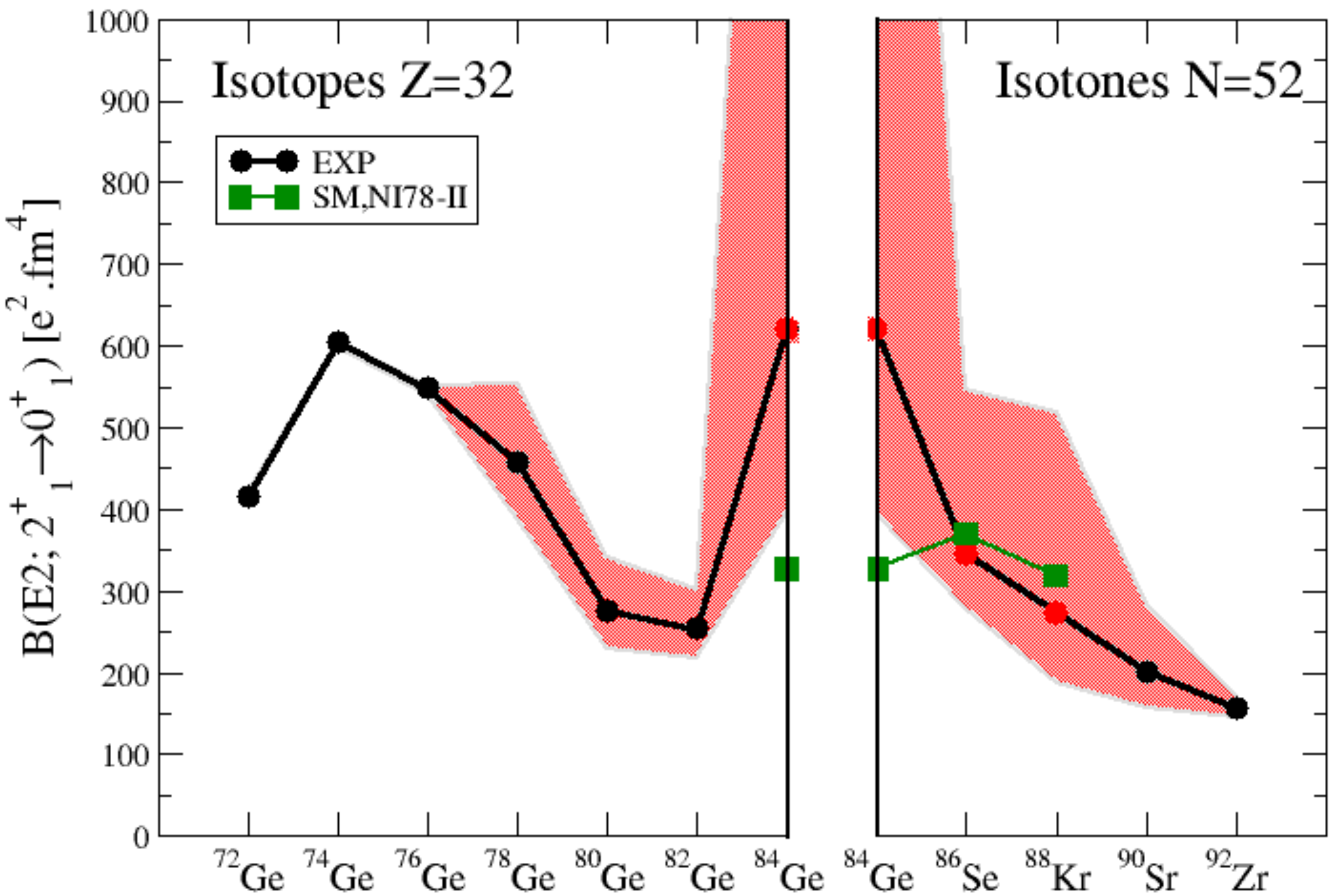
Interpretation



Sudden rise of collectivity after the N=50 shell closure

Collectivity still rises from Se to Ge at N=52 …

Interpretation



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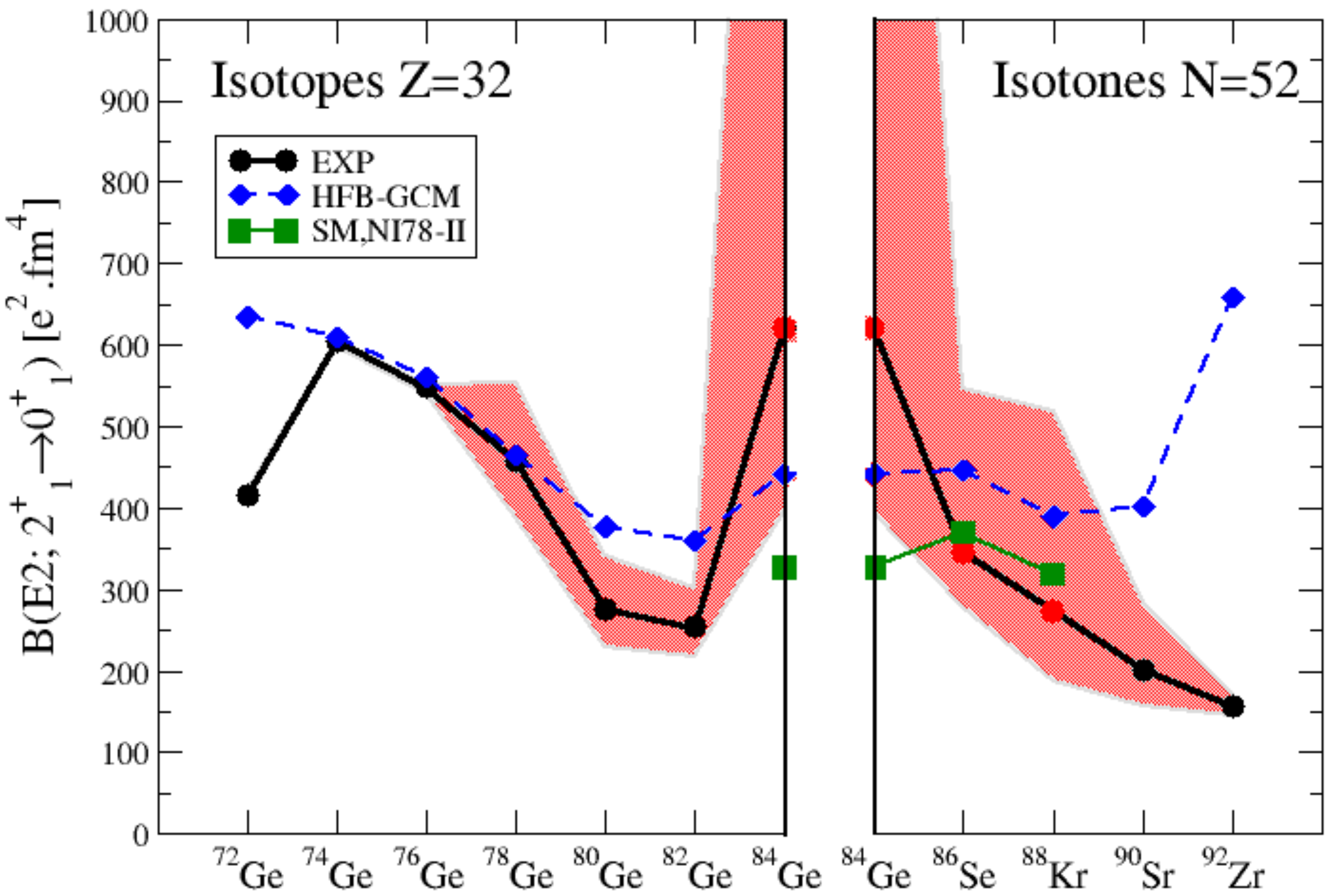

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HFB-5DCH Gogny D1S (Delaroche et al. Bruyères-le-Châtel, available online

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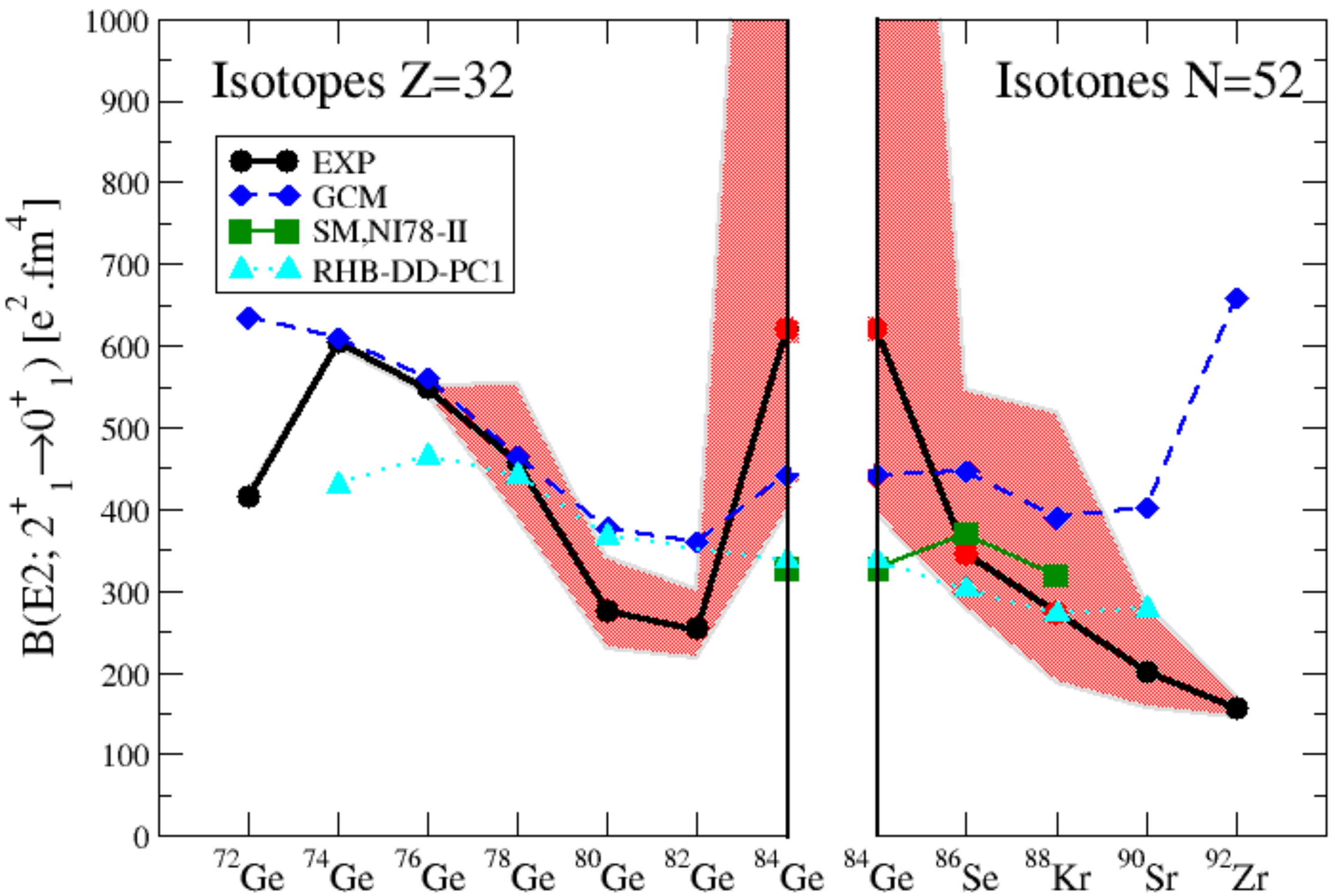

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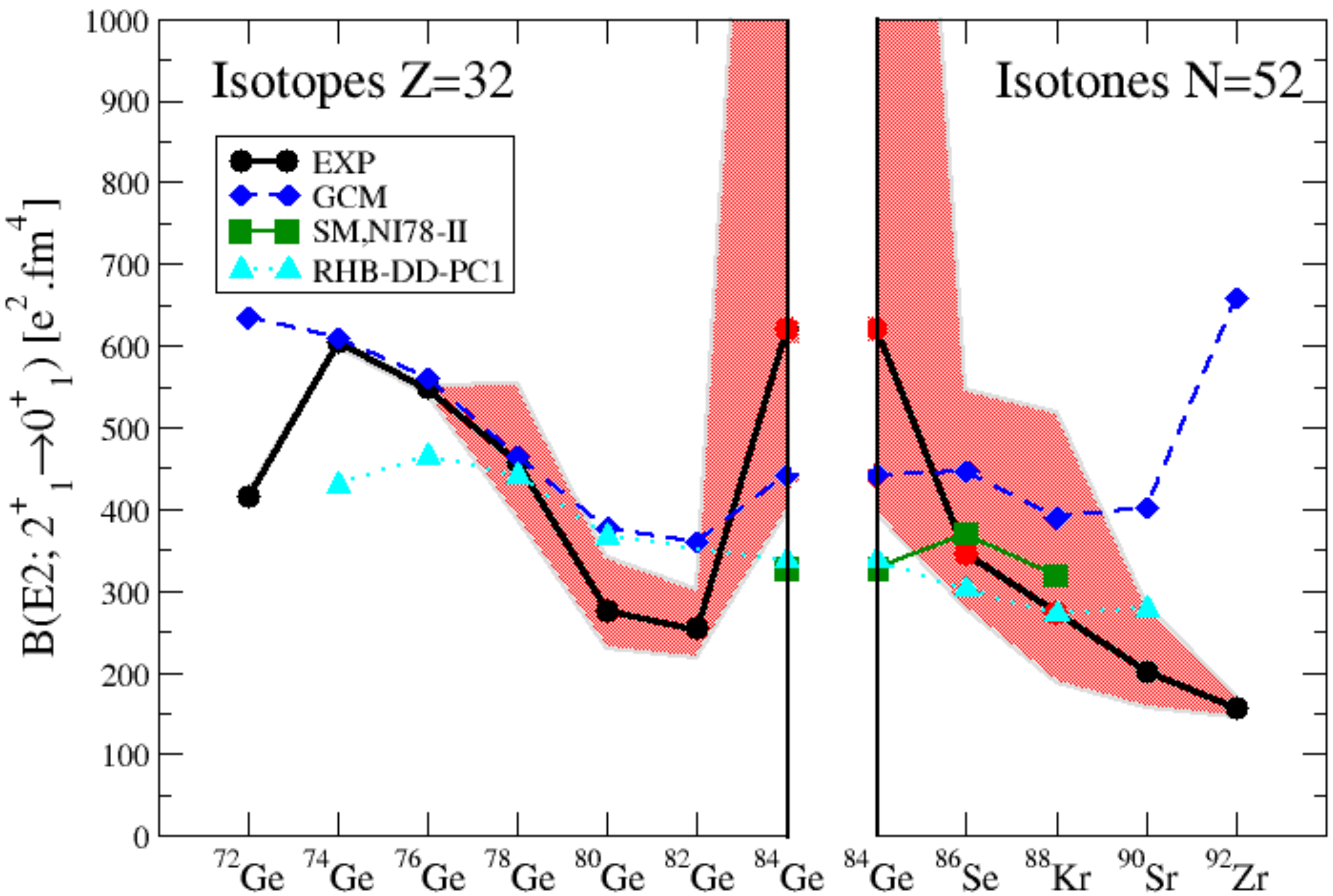
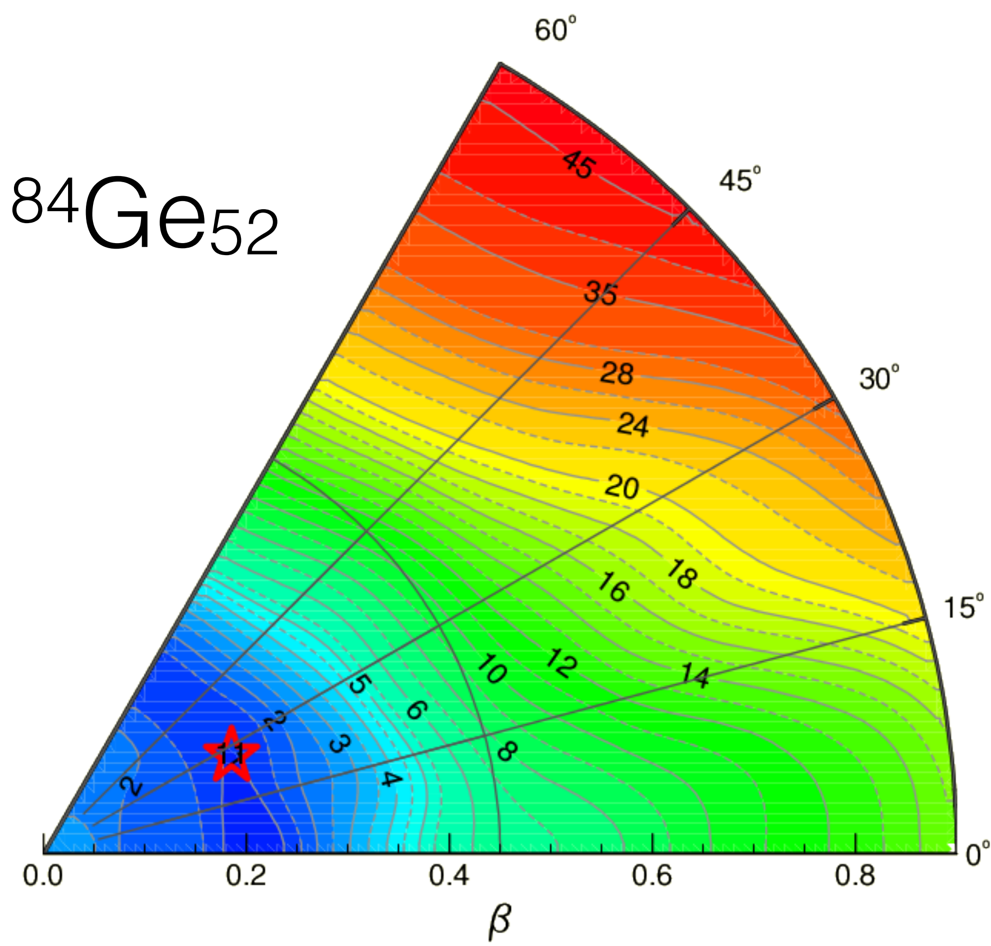


$^{84}Ge_{52}$



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Conclusions

First lifetime of excited states measured in ^{88}Kr

Lifetime measured with better accuracy in ^{86}Se

First lifetime measured in the very exotic ^{84}Ge

Unexpected enhancement of collectivity in ^{84}Ge (due to the N=50 gap weakening at Z=32?)

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Many results in the ^{78}Ni region are coming :
- Neutron monopole drift towards 78Ni
- Intruder states in N=49 isotones

Stay tuned !

Perspectives

- Multistep coulex in Ge isotopes (LoI at SPES, M. Zielinska, D. Verney et al) : E2 strength distribution

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- Multistep coulex in Ge isotopes (LoI at SPES, M. Zielinska, D. Verney et al) : E2 strength distribution

- <δr^2> measurement by laser spectroscopy in N=52 isotones (LINO at ALTO)

- Electron conversion spectroscopy : low-lying 0^+ state in ^{84}Ge ? (ALTO or/and GRIFFIN/TRIUMF)

Thank you for your attention !

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